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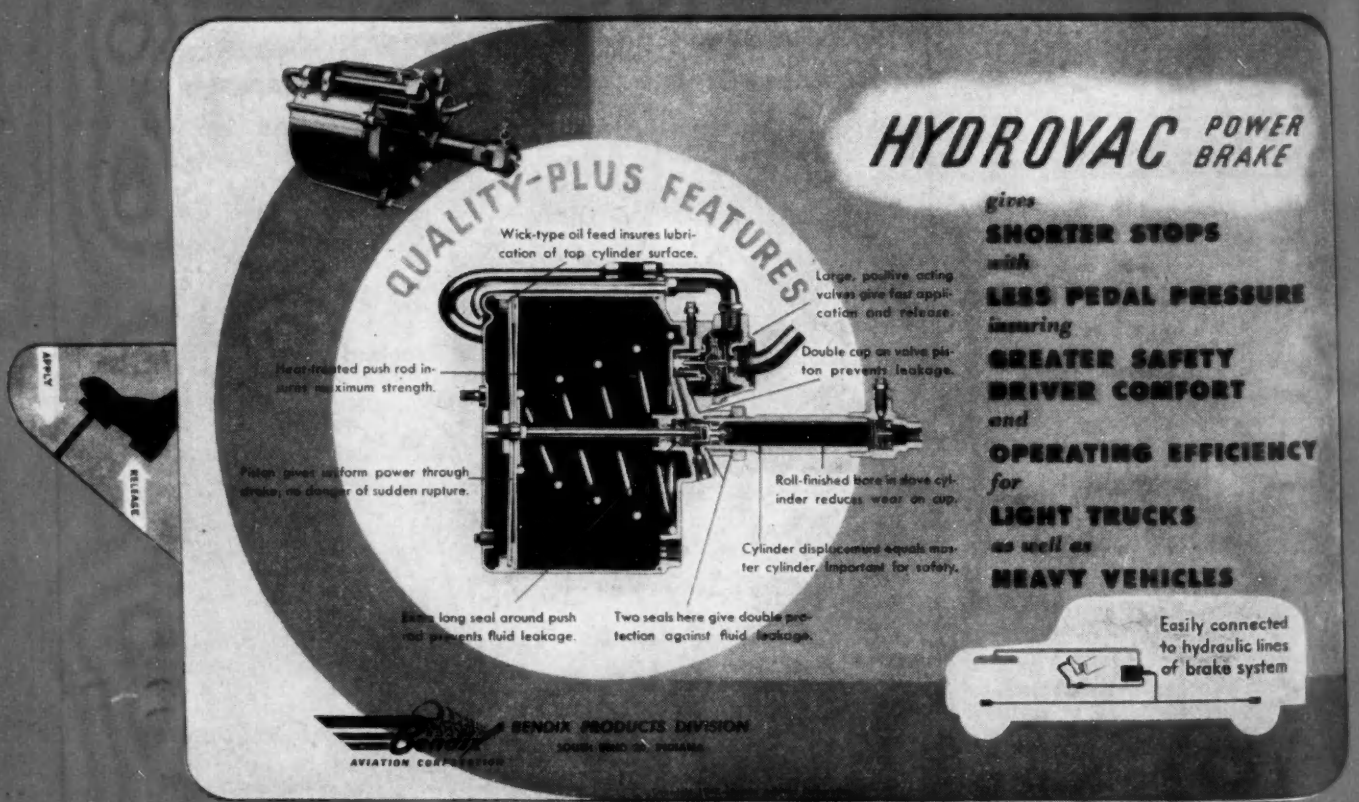
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Council Acts to Revise Dues and Fees Schedule

THE SAE Council, at its March 31 meeting in Philadelphia, adopted a new schedule of SAE dues and fees to provide greater stabilization of SAE income in future years and to meet increasing costs of operation due primarily to inflation. This is the first change in Society dues and fees in 18 years.

The new schedule, as adopted by the Council, is based upon the age of a member rather than grade of membership held. There is, however, no change in the grades of membership.

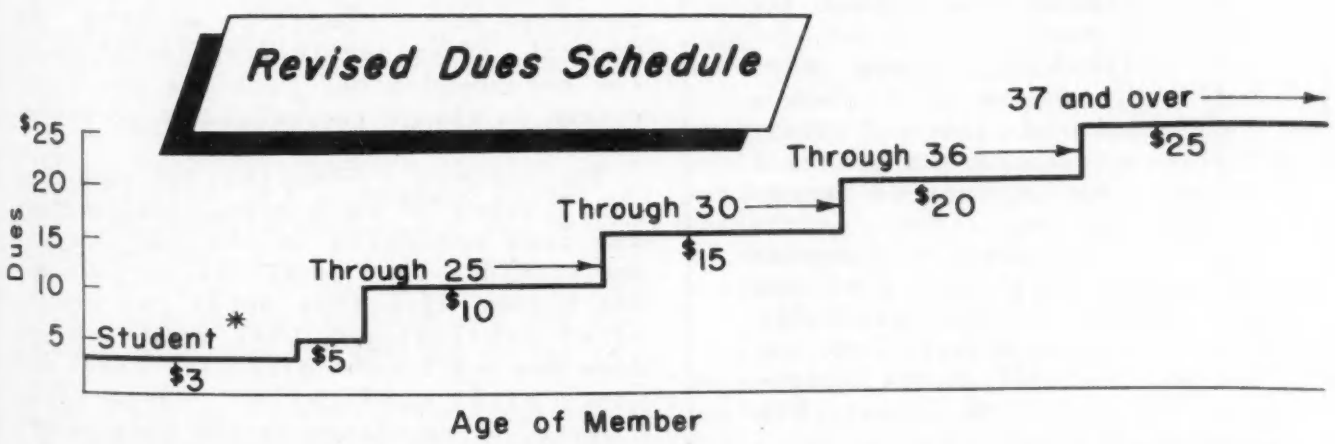
Highlights of the new schedule of dues and fees include:

- Provides needed additional income from relatively stable sources of member dues and fees.
- Dues will be the same for all members in a given age bracket, regardless of grade of membership held.
- Initiation and reinstatement fees will be based upon age rather than grade of membership to which a candidate is elected.
- Transfer fees will be eliminated. After a member has paid his initiation fee there will be no charges for transfer of grade.
- Dues and fees for Service Members and Foreign Members will be brought in line with dues and fees of other members.
- There will be no change in fees for Student Enrollment.

The new schedule for SAE dues and fees is as follows:

AGE RANGE	DUES	INITIATION FEE	REINSTATEMENT FEE*
25 and under	$10	$10	$5.00
26-30 incl.	15	15	7.50
31-36 incl.	20	20	10.00
37 and over	25	25	12.50

*Reinstatement fee waived if member resigns while in good standing.



*Student fee $3.00 while in school; $5.00 for first year after graduation.

It will be noted from the accompanying diagram that membership dues progress smoothly, without peaks created by transfer fees. A student entering the Society as an Enrolled Student may, if qualified, progress to a senior grade of membership without being called upon for payment of transfer fees. All that is required is that he pay the increased dues as he progresses from one age bracket to another. Members entering the Society, who do not progress directly from Student Enrollment, are required to pay the initiation fee of their respective age groups, regardless of the grade of membership to which they are elected.

Original study of the revision of SAE dues and fees schedules began in September, 1947, when the Society's Finance Committee urged the Council to obtain greater income from member dues to insure stability of income. The Finance Committee pointed out that the Society generally relies for more than half its income on advertising, which is volatile and subject to rapid shrinkage with downward trends of general business conditions. The Finance Committee further reported that advertising rates and charges for services to non-members had been increased and that the operating expenses of the Society had been cut heavily.

In receiving the Finance Committee's report, the Council asked its Executive Committee to study further the necessity for revising dues and fees schedules. The Executive Committees of the Membership and Sections Committees were consulted, and the Executive Committee of the Membership Committee asked to cooperate with the Council's Executive Committee in its investigation.

To gain some indication of the thinking of the members, the Chairmen of the Section, Group, and Activity Membership Committees were asked to comment on the proposal to change the dues and fees schedules and to state reactions to specific plans which were submitted by the Membership Committee Executive Committee. In some instances the local Membership Chairmen discussed the subject with their Governing Boards and Membership Committees.

After reviewing replies to the questionnaire, the Membership Committee Executive Committee and the Executive Committee of the Council recommended to the Council that dues and fees schedules should be revised and that the schedules outlined above should be adopted. The Council, after careful consideration of the recommendation, took the necessary action to change the schedules as recommended.

The Society's Constitution requires publication of such revisions in dues and fees schedules in the SAE Journal and provides that revisions in fees may not become effective until two months after publication; that revisions in dues may not become effective until one month after publication. There will, however, be no change in the dues schedule until October 1, 1948, the start of the Society's fiscal year.

Aero Meeting. . .

REPORT of the SAE National Aeronautic and Air Transport Meeting, April 13 to 15, will appear in the June issue of the SAE Journal because schedules have been upset by the typesetters' strike.

The 23 technical papers stimulated informative discussion on many engineering phases of aircraft, powerplant, and operation and maintenance throughout the three-day event.

An exhibit of engines, propellers, and some of the Navy's developments in pilot and flight engineer training was provided through the courtesy of Metropolitan Section.

All of the papers will appear in forthcoming issues of the SAE Journal, and are available in mimeographed form from the SAE Special Publications Department, 29 West 39th Street, New York 18, N.Y.

STRATOCRUISER'S Air Conditioning System

From a paper* by

R. L. Linforth

Air Conditioning Engineer

Boeing Aircraft Co.

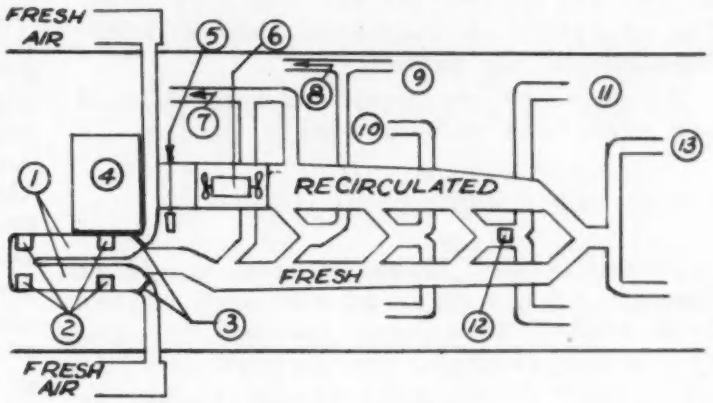


Fig. 1 - Schematic diagram of airflow in Stratocruiser air conditioning system

1 - combustion heaters
2 - temperature-sensing elements
3 - filters
4 - air recovery unit
5 - check valve
6 - recirculating fan
7 - control cabin supply
8 - forward cargo supply
9 - aft cargo supply
10 - forward upper deck supply
11 - aft upper deck supply
12 - program motor sensing element
13 - lounge supply

THE air conditioning system of the Boeing Stratocruiser circulates 1000 cfm of fresh air and vitified recirculated air to the plane's eight major compartments, supplying heating or cooling as needed, and maintaining sea level pressure in the cabin to an altitude of 15,000 ft.

In flight, fresh air is bled off the engine turbosuperchargers, ducted to a filter, warmed in a combustion heater if additional heat is needed, and led to the mixing chamber.

Air for recirculation is collected from the main passenger compartments and the control cabin and put through an air recovery unit. There a filter removes dirt and smoke, activated charcoal absorbs odors, and an evaporator cools the air if cooling is needed. From the air recovery unit, the recirculated air joins the fresh air in the mixing chamber.

The mixing chamber contains five compartments: two for the main cabin, and one each for the luxury lounge, control cabin, and cargo compartments. Except for the mixing compartment for the aft part of the main cabin the ratio of fresh to recirculated air in each compartment is controlled separately by a valve. Temperature is controlled by adjusting the valve to vary the ratio of warmed fresh air to cooled recirculated air.

Air for all cabin sections other than the control cabin passes through an air space between the fuselage and the cabin

*Paper "Design Considerations for Cabin Air Conditioning of Boeing Stratocruiser," was presented at SAE Annual Meeting, Detroit, on Jan. 16, 1948.

wall to plenum chambers above the sections. Air enters the cabins through large ceiling grilles and moves downward at a velocity of 15 to 25 fpm to exhaust grilles formed at the intersection of the cabin walls and floor.

Air is supplied to the control cab through four inlet grilles and exhausted through wall-floor grilles.

From the passenger cabins and control cabin, air is ducted under the luxury lounge and through the cargo compartments back to the lower body section. About 80% of the air enters the air recovery unit. The remainder is exhausted through pressure-regulating valves.

The paths of the fresh and recirculated air are shown schematically in Fig. 1.

FRESH AIR SUPPLY

During normal flight operation, 20 lb per min of air is bled off each of the four engine induction systems for the fresh air supply. The air is led off downstream of the exhaust-driven turbosupercharger and the intercooler in a stainless steel duct which passes through the engine firewall. A spring-loaded valve in the duct is held open by a fuseable link. In case of fire in the induction system, the link melts and the valve closes.

A second valve incorporates a flow-limiting venturi and a reverse-flow check valve. The venturi limits flow to a value which will not jeopardize the engine's altitude performance. The check valve prevents loss of cabin pressure in case the engine must be shut down. Being motor actuated, the check valve also provides a means of shutting off flow from the engine in case the air bled from that engine becomes contaminated with smoke or carbon monoxide.

Airflow from the outboard engines is ducted along the front spar of the wing to meet the air bled from the inboard engines.

Between the inboard engine and the body is a scoop cut in the wing leading edge. Air from the scoop is led directly to an electric-motor-driven centrifugal blower having a capacity of 40 lb per min at sea level. The duct from this blower unit meets the combined ducts from the engine bleeds in a Y-shaped duct containing a motor-actuated valve at the intersection. With the valve in position to connect the scoop to the fresh air supply line, airflow can be supplied by the blower or by ram. Normally, the valve keeps the line open to the scoop on the ground. The valve is actuated by a switch on the main landing gear oleo strut, so that on take-off the line from the scoop is closed and the line from the engine bleeds is opened. In case supercharger pressure is not available in flight, the pilot operates a switch which opens the valve and connects the scoop. Then ram supplies the air.

The operating procedure usually followed calls for the pilot or engineer to set up the turbo boost control of the engines for a carburetor deck pressure of, say, 32 in. of Hg before take-off - even though the turbosuperchargers are not in operation during take-off. As take-off is completed, the turbosuperchargers go into operation, providing air for the air conditioning system as well as for the engines. On the Stratocruiser, the 32-in.-of-Hg pressure can be maintained well above 16,000 ft. There is no difficulty in supplying cabin pressure.

Above 16,000 ft, the turbosupercharger setting is readjusted to provide a carburetor deck pressure slightly above the cabin pressure requirement, but with a minimum setting of approximately 24 in. of Hg. This readjustment requires only a small amount of attention from the crew member because it can be done in steps.

From each wing, air is ducted into the plane body, through a throw-away-type glass fiber filter, through a combustion heater and into the mixing chamber, where air supplies from the two wing systems meet.

The heaters are suspended from the ceiling near the aft end of the forward cargo compartment, where they are readily accessible for inspection during flight and for maintenance on the ground. The combined capacity of the two heaters is 400,000 Btu per hr. This is in addition to the heat added during compression.

A small amount of hot air from the heater is bled off for the defogging of all the windows in the control cabin except the seven main flight windows ahead of the pilot and copilot. (These seven are defogged and de-iced by means of a transparent electric conductive coating incorporated in each vane.)

To meet humidity requirements, steam can be introduced into the cabin fresh air system downstream of the heaters and the defogging bleed. The steam is generated by a three-element electric heater. One, two, or three elements may be used at a time.

RECIRCULATED AIR

The air recovery unit, located just below the combustion heaters, receives air which has already passed through the the passenger cabins or the control cabin and cleans and cools the air in preparation for its recirculation. Air entering the unit flows downward through glass fiber which removes dirt and tobacco smoke color, then across a bed of activated charcoal which removes body and tobacco odors, and finally across a cooling-unit evaporator which cools the air. Moisture which condenses on the evaporator collects in the plenum at the bottom of the unit and drains overboard.

This evaporator is part of two identical freon cooling systems, one system (except for the evaporator) being located in the outboard nacelle skate of each wing. Each complete unit consists of an electric-motor-driven 2-cyl compressor, a condenser cooled by an electric-motor-driven axial flow fan, a liquid receiver, the necessary valving, and the evaporator. Only the evaporator is located in the air recovery unit and shared by the two systems.

All the heat supplied by the air conditioning system is applied to the fresh air; all the cooling supplied is applied to the recirculated air. Temperatures within the luxury lounge, control cabin, forward section (sleeper section) of the main cabin, and the cargo holds are regulated independently of each other by valves which control the ratio of fresh air to recirculated air of the supply entering each of these volumes.

However, the ratio of fresh to recirculated air entering at the aft half of the main cabin is constant. Temperature there is controlled by varying the operation of the heating and cooling units. The master sensing devices for cabin temperatures are located at the aft end of the main cabin, and in the duct supplying this area are the sensing devices of the program motors operating cams to perform the following schedules of operations:

1 Full heating - keep both heaters on continuously.

2. Reduced heating - cycle both heaters as required.

3. No heat or cooling - keep heaters off.

4. Limited cooling - operate one compressor one cylinder only, and cycle heaters as required.

5. One-half cooling - operate both compressors one cylinder only, and cycle heaters as required.

6. Three-quarter cooling - operate No. 1 compressor both cylinders and No. 2 compressor one cylinder only, and cycle heaters as required.

7. Full cooling - operate both compressors both cylinders, with heaters off.

The program-motor sensing elements and the temperature selector at the attendant's station function as legs of a balanced resistance bridge.

The valves in the mixing chamber compartments which control the ratio of fresh to recirculated air are controlled by similar balanced bridges and program motors. Temperature differences up to 15 F between compartments may be maintained.

The addition of moisture for cabin humidity is controlled by a human-hair moisture—sensing element located in the aft exit duct from the main cabin, and the humidity selector at the attendant's station. The control unit energizes one, two, or three of the heating elements in the steam generating unit to bring sensed humidity into line with selected humidity.

The optimum effective temperature for passenger comfort is 68.5 F, as obtained by a dry bulb temperature of 73 F and 50% relative humidity, according to comfort codes. Such a moisture requirement entails excessive water capacity for operation at very low outside temperatures; therefore, the 68.5 F effective temperature is obtained by a dry bulb temperature of 76 F and 20% relative humidity, requiring a maximum moisture addition of 3 gal per hr.

The cabin temperature and humidity selectors are color coded to assist the cabin attendant in establishing the proper combination of dry bulb temperature and relative humidity to provide the optimum cabin effective temperature.

Both fresh air and recirculated air

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flow into each of the five compartments in the mixing chamber. Although the ratio of fresh to recirculated air can be varied by the motor-actuated valves in the four compartments for the forward half of the main cabin, the luxury lounge, the control cabin, and the cargo compartment, the total volume leaving each of the five compartments remains constant. A certain minimum of fresh air is always allowed to pass.

Distribution ducts run from the mixing chamber compartments to the appropriate cabin volumes. The distribution duct for the control cabin leads directly to its four grilles. For each of the other cabins, the air from the distribution duct to that section passes upward through an air space in the cabin wall between the fuselage and the cabin lining. Both the inside of the fuselage and the outside of the cabin wall are covered with glass fiber thermal insulation blankets, and the blankets are protected by impervious septums. The air passes between these septums, which form an air-tight, moisture-tight duct from cabin floor to ceiling.

FUSELAGE HEAT TRANSFER

The fuselage heat transfer is effected between the outside air and the air passing through the wall ducts. Because of the large volume of air flowing and the very satisfactory heat transfer coefficient of the fuselage, a unit volume of air does not lose or gain much heat on its trip up the side of the cabin. With the lowest anticipated outside air temperature, air entering the wall duct at 125 F will have the desired cabin temperature when it reaches the top of the wall duct. With the highest anticipated outside air temperature, air entering the duct at 70 F will attain the desired temperature by the time it enters the cabin. This results in an average cabin wall temperature very close to human body temperature, and very little radiation from bodies to walls takes place.

During the heating cycle, the dry bulb temperature of air leaving the ducts and entering the cabin is very close to the desired cabin air temperature. During maximum cooling, the air is a maximum of 15 F below the desired cabin temperature.

All of the cabin windows are dual glazed and are part of the wall duct system. Because the air passes between the panes, it completely defogs the windows, even at very cold outside air temperatures. Also it eliminates the usually serious window radiation.

The wall ducts dump air into a plenum chamber formed by the fuselage and the cabin ceiling. The septum and glass fiber blanket are not applied to the ceiling. The entire ceiling area serves as a grille through which the air enters the cabin in a solid downward flow. Because the entrance grille area is so large, air velocity is kept down to about 25 fpm throughout the volume.

Air exhausted from the passenger and control cabins moves toward the lower body center section, where the air recovery unit and the pressure-regulating exhaust valves are located. In the cargo compartments the air travels inside the guards over the control cables and electrical and hydraulic equipment.

Air exhausted from the cargo compartments, toilet areas, and the galley is never recirculated. It flows overboard through venturi which limit the flow. Installed with the venturi in each cargo compartment are photoelectric smoke detectors to warn of fire.

Most of the air enters the air recovery unit and is recirculated, but an amount equal to the fresh air flow, minus leakage and minus the flow exhausted directly overboard, leaves the plane through two pressure-regulating valves. Both valves are capable of maintaining a fixed maximum pressure differential - the design value for the maximum difference being 6.55 psi in this case. One of the two valves can be set to maintain automatically the value selected for cabin absolute pressure. The one valve equipped with this variable isobaric feature is connected to the operating head of the second valve so that it also performs the isobaric function. This provides dual differential control, yet eliminates the possibility of the two units' vying for control.

The maximum-pressure-differential function overrides the isobaric function. Thus, if a cabin altitude of sea level is selected, the valves will maintain sea level pressure in the cabin up to an airplane altitude of 15,000 ft - the altitude where the pressure difference between the

cabin and ambient air is 6.55 psi. Further increase in airplane altitude will be followed by increase in cabin altitude. The two pressures will vary so that the 6.55 psi difference is never exceeded. When the plane is at 30,000 ft, the cabin pressure will correspond to 8000 ft.

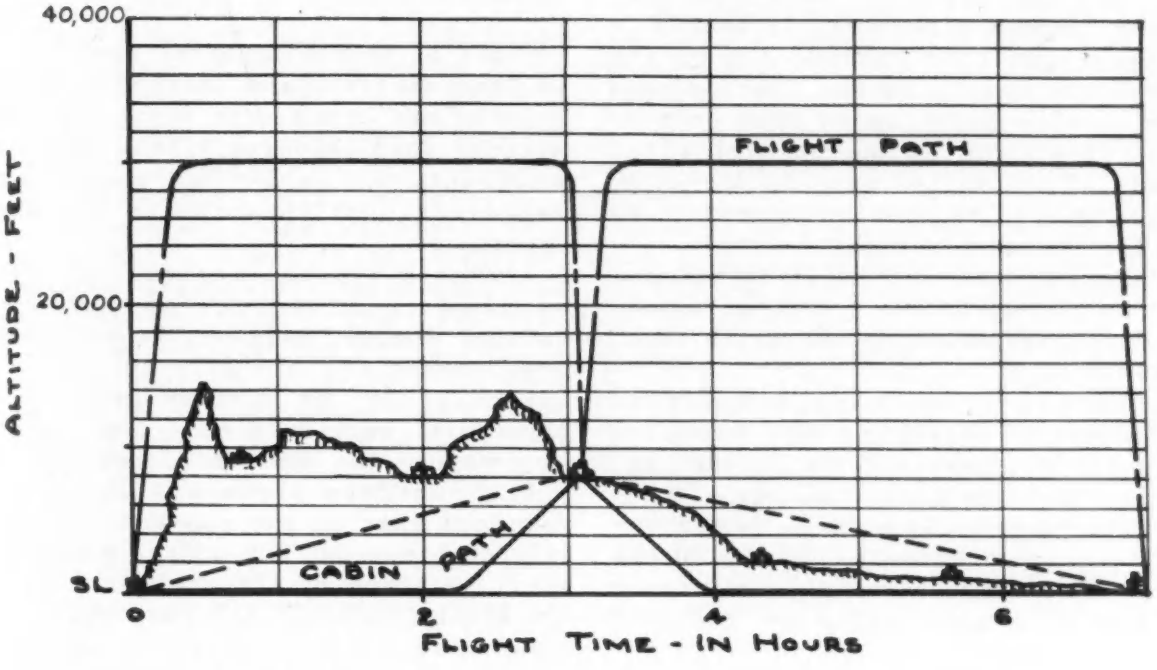
As long as the pressure difference is not exceeded, the cabin does not have to ascend or descend at a rate higher than desired. If the aircraft rate of ascent is 1000 fpm, it will take 30 min for the plane to reach an altitude of 30,000 ft. The flight crew can select a final cabin absolute pressure of 8000 ft, with the cabin to be ascending from sea level at a rate of 266 fpm. In this way, cabin altitude will arrive at 8000 ft at the time when the airplane reaches 30,000 ft. Fig. 2 illustrates such a flight plan.

Two instruments located at a crew station in the control cabin are set according to the flight plan. They can be set at any time during flight for either ascent or descent. A third instrument indicates the cabin altitude, the airplane altitude, and the existing differential pressure.

Besides the two main cabin-pressure regulators, there is another motor-actuated valve, located on the nose wheel well, which assures cabin pressure release on the ground. A switch on the main landing gear oleo strut opens the valve to the outside air when the strut is compressed and closes it when the strut is extended. A manual switch is provided to open the valve when the strut is not compressed, if such action becomes necessary.

One other pressure-regulating valve operates in emergencies where the airplane must descend rapidly. When the plane has descended far enough so that cabin pressure and ambient pressure are about equal, a large spring-loaded flapper valve admits air to the tail cone volume. This volume is normally at ambient pressure, and the structure is designed accordingly, but in case of rapid descent, the pressure in the tail cone might lag behind ambient pressure. Then the outside air would exert pressure on the structure. The flapper valve bleeds cabin air into the volume, insuring that no more than 0.4 psi external pressure will be exerted on the aircraft fuselage.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)



■ Fig. 2 - Comparison of cabin pressure path and airplane ambient pressure path

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This paper will be published in full in SAE Quarterly Transactions.

KINGPIN O

SHARPLY increasing kingpin offset in fifth-wheel mounting on tractor-semi-trailers, and careful exploration of the possibilities of making somewhat higher plate heights compatible with reasonably low flat body floors is indicated by a re-examination of the problem.

Empirical determination of proper offset seems to be inadequate to meet to-day's requirements. Trial and error methods often result in costly errors and, because of the interdependence of various factors involved, are often fraught with many difficulties.

The magnitude of offset affects load distribution, steering, braking, tire wear, riding qualities, maneuverability, traction, safety and overall length.

Some of these considerations are affected favorably, others unfavorably by the amount of offset. Furthermore, the effects are often in conflict making the optimum offset hard to find.

For equitable load distribution between the axles, and the concomitant effects upon tire wear, a large offset seems desirable. In a conventional two-axle tractor and single-axle semi-trailer, employing uniform tire size all around, a sufficient offset to provide 40% of the gross vehicle weight on the tractor rear and the trailer axles would load each of the 10 tires equally under full rated load and, if the latter were loaded up to the legal limit, the maximum gross train weight for the combination.

But this would be difficult to achieve without an extremely short tractor wheelbase and without mounting the fifth wheel excessively high.

Maximum practicable offset favors positiveness of steering and promotes maneuverability, particularly in backing, but it also involves more steering effort. Jackknifing tendency is reduced by the extent of kingpin offset; but on short trailers, this may push the support wheels so far back that nose-diving may become a hazard.

Riding qualities are generally better with an appreciable amount of offset, but the saving in overall length may be disappointing. Turning radius is hardly affected at all by the amount of kingpin offset; but offtracking is reduced as kingpin offset increases.

Regardless of the relative desirability of different amounts of kingpin offset from these various considerations, there are definite geometric limits on how far ahead of the tractor axle the kingpin may be placed.

LOAD DISTRIBUTION

First of several general considerations is load distribution. Although the semi-trailer has other more basic advantages, maximum load capacity within legislative restrictions is by far the principal desideratum which inspires their widespread use.

Although weight limitations are prescribed in a variety of ways in the various states, axle weight maximums are predominant and bid fair to become even more so. For the maximum gross weight, obviously, each axle must bear as nearly as possible the maximum allowable weight.

With uniform tires all around, this requires that in the conventional three-axle combination, 20% of the gross weight shall be borne by the tractor front axle and 40% by each of the other two.

Because of the variation in unladen tractor weights and the distribution as between tractor axles, to secure this ideal distribution will require different kingpin offsets for various individual

OFFSET

EXCERPTS FROM A PAPER * BY

Merrill C. Horine
Mack Mfg. Corp.

combinations.

In the case of a tractor rated for 40,000 gross train weight having an unladen weight, with fifth-wheel lower half of 7750 lb, distributed 54% on the front axle and 46% on the rear, and a wheelbase of 146 in., a kingpin load of 19,250 lb must be located 36-1/2 in. ahead of the rear axle to secure 18,000 lb on the rear axle and 9,000 lb on the front.

Such a kingpin offset is impracticable on standard tractors. In individual cases, with different tractor weights wheelbases and distribution of unladen weight, this figure will vary, but in every case the ideal of uniform tire loading throughout will be impractical. From the standpoint of load distribution, the maximum practicable kingpin offset is desirable.

A more moderate offset of approximately 14 in. is the maximum which can be tolerated with prevailing tractors and trailers. This falls short of the ideal distribution but it offers an appreciable gain in gross train weight over that where the kingpin centered over the tractor axle or offset to a lesser extent.

CLEARANCE ANGLE

A limitation besetting radical kingpin offsets is clearance angle, or the maximum angularity in a vertical plane between the frames of the tractor and semi-trailer which will leave safe clearance between the end of the tractor frame and the bottom of the semi-trailer. The 14-inch offset, at conventional plate height permits a clearance angle of 10 deg, which would seem ample for the worst conditions to be anticipated on the highway.

TRACTION

Maximum traction is obtained where the maximum percentage of load occurs on the driving wheels. Assuming the trailer axle carries the full legal load, maximum traction is secured with zero kingpin offset.

BRAKING

Unlike traction, braking is affected seriously by weight distribution. In the conventional tractor-semi-trailer, only one axle drives, so that the percentage of load on this axle alone is significant.

In an ideal braking system, the braking force at all times would be proportional to the imposed load on each axle.

Disturbing influences include brake torque reaction, moment of inertia at the two centers of gravity, gradients and, greatest of all, variations in the location of the centers of gravity under different loadings of payload. Only the latter is affected appreciably by kingpin offset.

Summarizing effects of kingpin offset on braking it seems justifiable to conclude that both the effectiveness and safety of braking are promoted by as much kingpin offset as the limitations permit.

STEERING

Optimum steering must always be a compromise between ease and positiveness. Less weight on the front tires makes steering easier, but the tendency for front wheel skid is increased. Placing the kingpin directly over the tractor rear axle reduces steering effort, but on slippery upgrades this introduces dangerous uncertainty of response.

*Paper "Overall Considerations in Fifth-Wheel Mounting on Tractor-Semi-Trailers" presented at the SAE 1948 Annual Meeting, Jan. 13, Detroit.

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But a definite kingpin offset does decrease the tendency to jackknife which to a very real degree does represent an aberration of steering.

It might seem that kingpin offset, to the extent it pulls the whole trailer forward would reduce the turning radius. This would be so if the distance from the kingpin to the trailer axle center were unchanged.

Modifying the distribution of trailer weight between the kingpin and trailer axle can be done either by moving the kingpin or the trailer axle backward with relation to the trailer center of gravity. Interferences are to be anticipated both as to cab clearance and trailer throat clearance. The preferable procedure would be to move the trailer axle back. The distance depends upon the effective wheelbase of the trailer.

Turning radius in a tractor-semi-trailer can be deceptive. A rigid six-wheeled truck with the same body length, having materially greater turning radius, occupies decidedly less road width on a turn than the corresponding tractor-semi-trailer, because of the greater degree of off-tracking characteristic of the articulated combination.

MANEUVERING

Closely related to steering is maneuvering. Much of the value of the tractor-semi-trailer lies in its high degree of maneuverability in close quarters. The secret of effective backing of tractor-semi-trailers is to so handle the tractor that it directs the trailer wheels and then follows the trailer.

With the kingpin directly over the tractor rear axle, this side movement of the kingpin is possible only to the extent that the tractor itself is moved sidewise; but with an appreciable kingpin offset, this sidewise movement is materially augmented, making the train far more manageable. This is particularly noticeable in straight backing.

RIDING

Ease of riding is far from ideal in any tractor-semi-trailer. The driver rides on a short wheelbase with rear springs relatively stiff when running light. Extreme kingpin offset cannot make a Rolls-Royce of a tractor, but to the extent that it distributes a part of the fifth wheel load to the front axle, it thereby reduces the extremes of loading on the rear axle.

Where the trunnion is directly over the tractor axle, the tractor in effect becomes a bell-crank whose fixed pivot is the rear axle, so that all of the reaction from the horizontal thrusts is resolved into vertical action on the front springs.

LIMITATIONS ON KINGPIN OFFSET

Prevailing practice limits kingpin offset to between 4 and 6 in. ahead of the tractor axle and most standard trailer models have been designed with weight distribution and throat clearances appropriate to that amount. Tractors, too, and the standard SAE CA dimensions seem to have been set up in most instances with such a degree of offset in mind; the clearance angle also limits how far we may go.

One of the first dimensional limitations is the necessary cab clearance for jackknifing. The formula for the solution of this maximum offset in conventional tractors works out at about 14 in. in most cases.

The controlling dimension is the diagonal from the kingpin to the front corner of the body. The width of the body, rather than its shape limits how far forward the kingpin may go while providing proper jackknifed clearance.

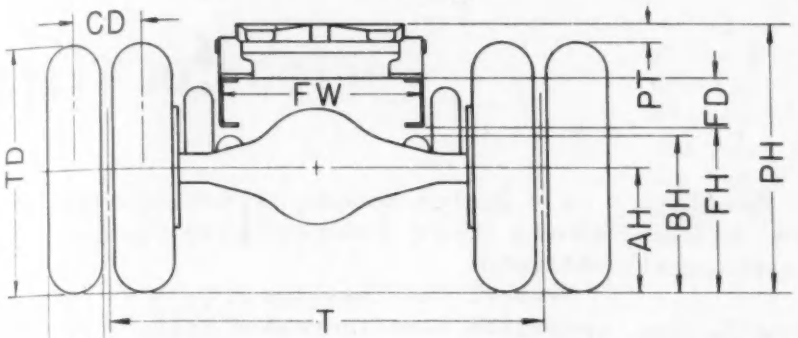
Another limitation is that of trailer throat clearance. This is subject to great variation between different trailers, but in almost all cases the trailer can be adapted to accept the maximum offset permitted for proper cab clearance and clearance angle.

COUPLING HEIGHT

Dimensional location always involves three dimensions and we must deal with its transverse and vertical location. The first presents no problem. The latter is of considerable significance. For trailer stability, the ideal vertical location of the fifth wheel plate would be as high as possible.

$$PH = AH + \frac{TD}{2} + \frac{(FH-BH)(2T+CD)}{FW} + 2$$

$$PT = PH - AH - \frac{TD}{2}$$



TD - TIRE DIAMETER
CD - CENTER DISTANCE
TW - TIRE WIDTH
T - TREAD
AH - AXLE HEIGHT*
FW - FRAME WIDTH
BH - BUMPER HEIGHT (BOTTOM OF RUBBER)
FH - FRAME HEIGHT*
FD - FRAME DEPTH
PH - PLATFORM HEIGHT*
PT - PLATE TO TIRE

* - LOADED

■ Fig. 1 - Plate height analysis, taking into consideration the transverse angular displacement of tractor rear axel with frame when running ever rough roads

Exactly the opposite is true with respect to tractor stability. Since the tractor's lower center of gravity and its four-point support is the more stable of the two, overall stability of the train calls for as high a fifth wheel as other considerations will permit.

Floor heights of trailers should be kept as low as practicable both for the sake of keeping the center of gravity down for safety and avoiding excessive load platform height. This definitely limits the height of the fifth wheel plate.

To standarize trailer coupling heights for the sake of promoting sidesway stability, interchangeability of tractors and trailers and uniform load platform heights, a Subcommittee on Motor Vehicle Design of the Transportation & Maintenance Activity of the SAE rendered a report which was published in the SAE Journal of April, 1937, setting the uncoupled height of the fifth wheel plate at tire height, plus coupled clearance of 2-1/2 in. plus tractor spring deflection of 4 in. or 6-1/2 in. above the tire height.

But this analysis does not take into consideration the transverse angular displacement of the tractor rear axle with respect to the tractor frame when negotiating uneven surfaces, but approaches the problem in profile alone.

As shown in Fig. 1, an analysis has been made from this standpoint. This dictates that the plate heights required for complete avoidance of interference between the tractor tires and the underside of the trailer may be considerably above those. In practice, interference between the tractor tires and the underside of the trailer does sometimes occur. The question therefore resolves itself into whether the advantages of the lower trailer floor heights resulting warrant the risk.

(Complete paper on which this article is based is available from SAE Special Publications Department, Price: 25¢ to members, 50¢ to non-members.)

AMENDMENTS to SAE By-Laws were approved by the Council at its March 31 meeting. Revisions were aimed chiefly at bringing By-Laws into harmony with Constitution changes recently approved by the membership.

One change names in the By-Laws the Standing Committees - most of which were formerly named in the Constitution. These committees now are: Constitution, Finance, Meetings, Membership, Membership Grading, Placement, Public Relations, Publication, Sections, Student, and Technical Board.

Copies of the revised By-Laws are available upon request to John A. C. Warner, Secretary and General Manager.

DIRECT INJECTION

for Large

DIRECT fuel injection has been developed for the Wright 18-cyl engine because it offers many advantages over conventional carburetion, such as:

1. Reduction in backfire hazard, due to the elimination of the combustible mixture in the induction system. Intercoolers may be made lighter.

The elimination of the backfire hazard has made direct injection a requirement for some commercial airplanes.

2. Easier starting, shorter warmup, and reduced backfiring, due to injection of fuel directly into the combustion chamber.

3. Reduced icing condition, because of the elimination of the refrigeration effect of mixing fuel and air in the induction system.

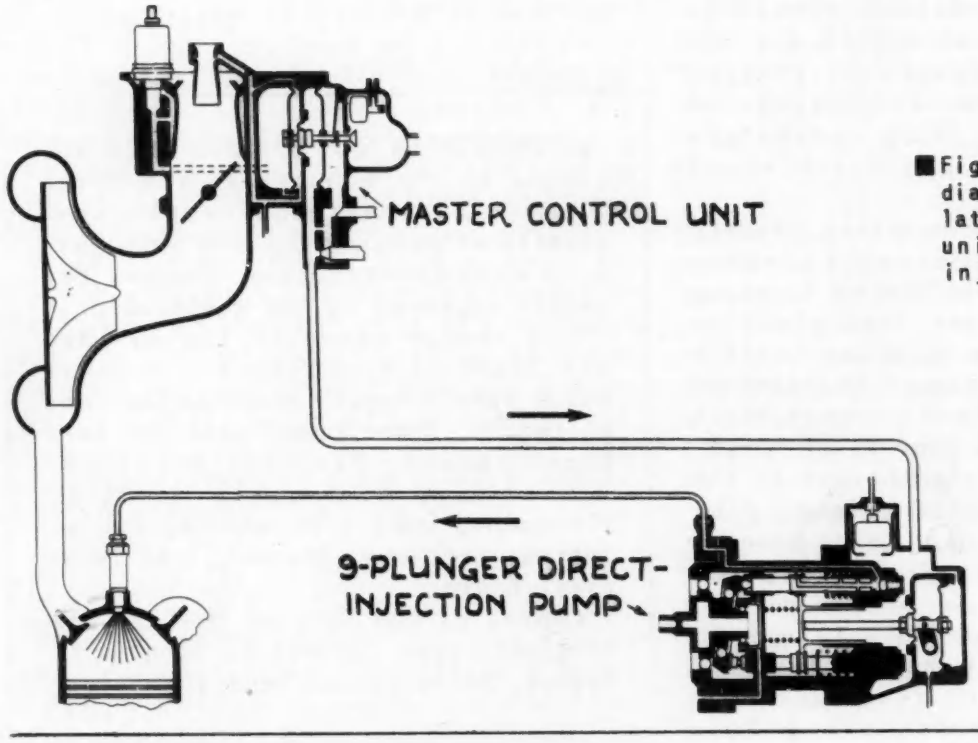
4. Better economy, since experience has shown that leaner mixtures can be obtained.

Overall fuel savings of 2-3% in airplane operation have increased airline payloads 200-300 lb, because of the decrease in fuel load.

5. Reduced engine maintenance, because the better distribution results in a smoother-running engine with less wear on the engine parts.

It has been found by the airlines that smoother engine operation and reduced vibration not only reduce maintenance cost, but also contribute to a smoother airplane and greater passenger comfort.

6. Improved cylinder cooling, due to the complete vaporization and latent heat loss of the fuel within the engine



■ Fig. 1 - Schematic diagram showing relation of principal units of direct-injection system

DEVELOPED

Aircraft Engine

BASED ON A PAPER* BY

J. T. Marshall

Bendix Products Division
Bendix Aviation Corp.

combustion chamber and less spread between the highest and the lowest temperature cylinders, due to better fuel distribution.

7. Improved acceleration, because the engine receives fuel from the pump at the nozzle faster than the normal time loss for the enriched mixture to pass through the induction system in a carbureted engine.

8. Better operation of engines in the Arctic.

METHOD OF OPERATION

Fuel is introduced from the system directly to each cylinder by means of a nozzle in the cylinder head spraying fuel into the combustion chamber. This process is carried out independently of the air induction system but at timed intervals during the intake stroke of the engine.

This system should be distinguished from the injection or pressure carburetor which sprays fuel in a continuous stream to the eye of the engine impeller or supercharger.

In both cases a means must be provided to proportion the fuel and the air.

Fig. 1 shows the relationship of the principal units of the direct-injection system. The master control unit automatically increases or decreases the airflow and also measures the fuel before it goes to the direct-injection pump. Here the fuel is divided into as many equal parts as there are engine cylinders. The pump also raises the pressure sufficiently to force fuel through the outlet lines directly into the engine cylinder through the spray nozzle.

The nozzle, which is located as near the top of the cylinder as possible, is set to an opening pressure of 500 psi. The nozzle is of the poppet type, spraying fuel in a cone shape having a 30-deg included angle. The peak line pressure between the pump and the nozzle will vary between 750 psi at engine idle to about 2000 psi at full engine power. This increase with output is due to line resistance to flow, the nozzle spring setting and the increase in fuel flow with decreasing time, with increase in engine speed and power, that is to fuel column inertia.

The system is designed to use the highest octane fuels available – those having the highest lead content – since such fuels have been found to be the most detrimental to the injection pump design.

Direct injection for the gasoline engine is comparatively new, and much development work remains to be done. At present it is very costly, due to the high precision necessary in manufacture to obtain reliability in service. One great difficulty, besides making the system work satisfactorily, has been to learn how to manufacture, first, a pump that could perform reliably and, second, how to repeat this accomplishment on a production basis. It would be very desirable to make simpler and less expensive units for use on smaller engines.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

*"Direct Injection for Wright 18-Cyl Engine" was presented at the SAE Annual Meeting, Detroit, Jan. 14, 1948.

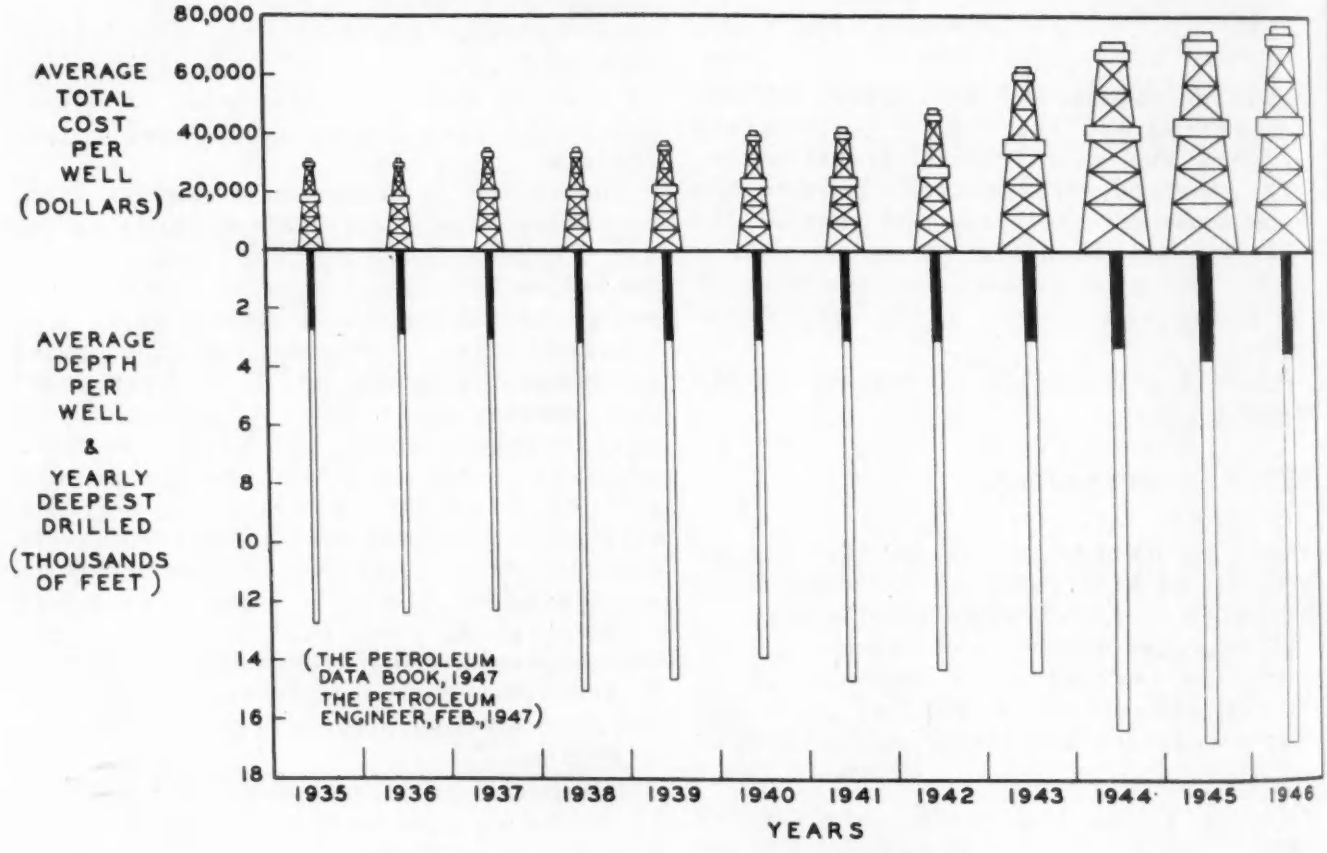
Higher Costs, Shortages Seen

PREDICTIONS and conclusions that should be kept in mind when studying the problem of improving the economy of passenger cars while maintaining performance include:

1. The octane-number level of gasoline will not increase at as fast a rate as it has in the past because over $4,000,000,000 must be spent over the next several years to increase production and refining capacity to meet quantity demands alone. Moderate increases in anti-knock quality should result from the installation of modern equipment in this expansion program.

2. Automotive design and fuel marketing policies can bring about a readjustment of the spread in quality between the regular and premium grades to give, with present refining equipment, about 20% premium gasoline sufficiently high in anti-knock to meet the requirements of proposed high-efficiency passenger-car engines.

3. Rather than depend solely on increases in gasoline octane number for improved economy, engineers of the automotive industry should examine the



■ Fig. 1 - Oil well costs and drilling depths

Hindering Fuel Development

EXCERPTS FROM A PAPER * BY

W. M. Holaday

Socony-Vacuum Oil Co., Inc.

manner in which the anti-knock quality of present gasoline is being utilized. It seems apparent that any design that leads to fuller utilization of anti-knock quality than do present vehicles will result in improved economy.

PETROLEUM SUPPLY AND DEMAND

The fact that crude oil production and crude runs to refining equipment are currently at an all-time high has been widely publicized. In spite of this high level, however, proved reserves - oil that can be brought to the surface economically and made available for utilization - are increasing slightly and are expected to continue to increase as a result of the added emphasis placed on exploration and improved production and recovery procedures. One important factor should be noted: 84% of the increased reserves in 1946 was composed of extensions and additions to fields already under development, while only 16% may be credited to newly discovered pools.

As would be expected, new reserves are becoming more difficult to discover. The increased cost and complication of drilling new wells is indicated in Fig. 1.

This situation is not too encouraging, but production researchers are optimistic over the possibilities of making new finds of major proportions in hitherto unexplored territories, such as tidelands, off-shore areas, and those areas in the Rocky Mountains that previously had been considered remote and bordering on the inaccessible. Off-shore areas in the Gulf of Mexico are currently receiving concentrated attention. Drilling is now going on in several locations beyond the sight of land. The first discovery, some 18 miles off shore, was reported recently.

Crude Oil Quality - The quality of fuels is affected to a considerable degree by the characteristics of the crude from which they are produced. From the motor fuel standpoint, increased sulfur content is the principal problem presented by some of the recently discovered

*"Efficient Production and Utilization of Motor Gasoline" was presented at the SAE Annual Meeting, Detroit, Jan. 14, 1948.

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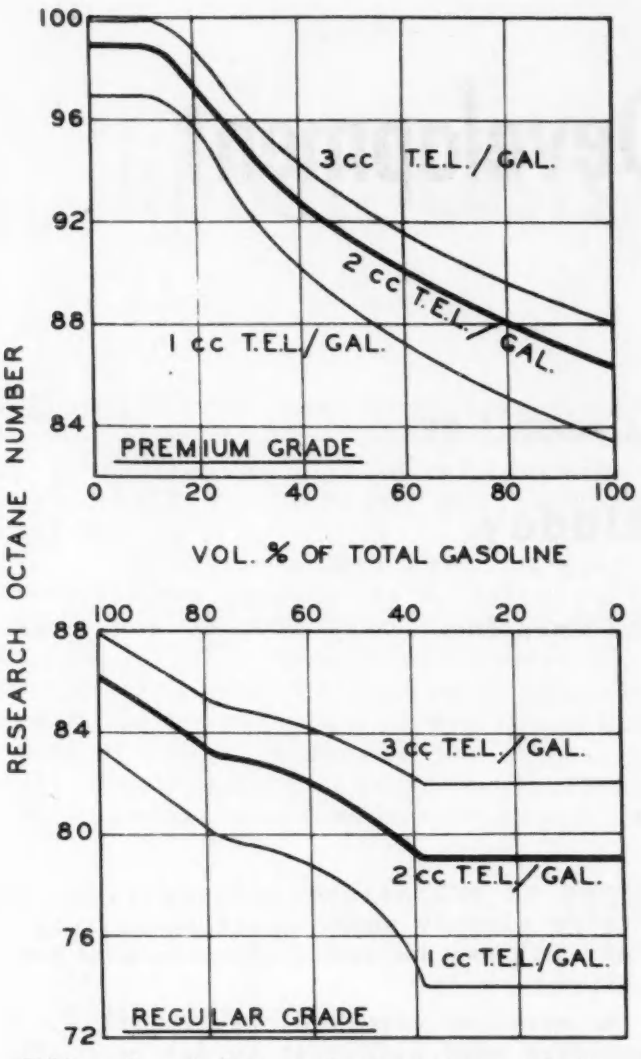


■Fig. 2 - Volume-octane number relations between regular and premium gasoline

domestic crudes as well as by those from the most prolific foreign sources.

The second quality is the hydrocarbon base. The majority of new discoveries are paraffinic or, at best, mixed base, which presents the problem of obtaining high gasoline yields of satisfactory anti-knock quality. Straight-run gasolines of 350 F end point from these sources generally have 35-40 octane number, whereas gasoline from some of the old naphthenic crudes frequently have 70-75 octane number. An anti-knock quality spread in the same direction, although not as large, is evident in gasolines obtained by reforming and thermally cracking naphthas and gas oils from paraffinic and naphthenic crudes.

Gasoline Anti-knock Quality - The potential flexibility of the refining industry can best be illustrated by analyzing the volume-octane number relationships of present-day gasoline production. Fig. 2 shows the relationship between the volume of premium and regular grades and the resultant anti-knock quality for each grade. It can be seen that the industry can make available with an adequate supply of tel - a limited volume of high-octane-number fuel, specifically, about 20% premium gasoline having a Research octane number of 97 with 2 ml of tel per gal and 80% regular gasoline having a rating of 83 with 2 ml of tel per gal.

The marketing of a third grade of gasoline - a "superpremium" fuel - is not feasible. The required capital investment is excessive and, in addition, the materials required for the installation of additional pumps, lines and tankage at the refinery, bulk terminal, and service station would have to be drawn from the same limited stocks now being used for the expansion of crude oil production and refining facilities.

Whether or not the industry will be in a position to maintain past trends in anti-knock quality is a serious question. Such improvements cannot be obtained simply by turning valves and readjusting operating conditions on equipment now in use. All of it is now being operated at maximum throughout to meet quantity demands. Refining facilities must be built to meet these increasing quantity requirements before emphasis can be placed upon construction for quality.

REFINING TO PRODUCE GASOLINE

In general, cracking processes and those converting the heavier parts of the fuel gas into gasoline produce low-cost octane numbers because the product value is increased. In contrast, the reforming processes produce high-cost octane numbers, since the product value is decreased. Fig. 3 shows a plot of the investment required for various types of refineries against the octane number of the gasoline produced by these refineries.

The investment required for today's octane numbers is high, and will increase rapidly if higher anti-knock

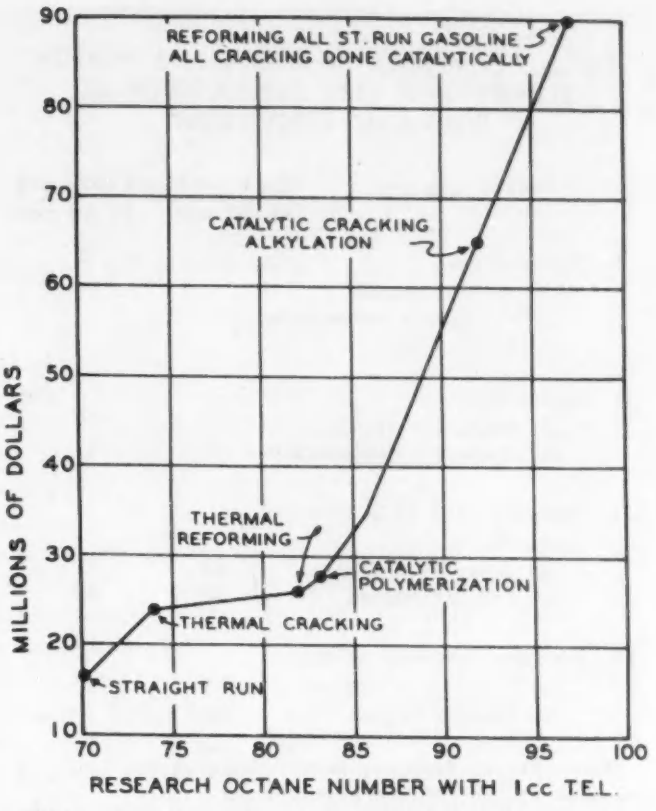
quality gasolines are required. During the war years $927,000,000 was expended on major projects in refineries. Of this amount, $864,000,000 was spent only on facilities for the production of 100-octane aviation gasoline. The construction of catalytic cracking units accounted for the largest part, alkylation units for a smaller portion, and lesser amounts for crude fractionating units. Charging capacity to catalytic cracking units increased to over 1,000,000 bbl per day.

Between 1941 and 1946 premium and regular grades increased *barely 3 octane numbers* in spite of the fact that aviation fuel production had been largely diverted to motor gasoline by 1946. In other words, an increase in overall fuel anti-knock quality of 1 octane number then costs about $300,000,000.

It is generally agreed that the refining industry must be expanded to handle another 1,000,000 bbl per day of crude to meet anticipated demands here and abroad. This expansion, maintaining today's quality level, and the required increase in distribution facilities will cost about $1,500,000,000 at today's prices. An outlay of over $2,750,000,000 will be required to find, produce, and distribute the additional crude oil to fill these demands. This total investment, exceeding $4,250,000,000, must be made to meet the anticipated demand for petroleum products and must, therefore, receive priority over investments aimed solely at improving the quality of products.

There is also a limit to the amount of refinery and crude producing equipment that can be installed in one year. Among the shortages causing this limit are steel, motors, pumps, compressors, and skilled construction workers. Consequently, the expansion will take several years. After the expansion is completed, further investments will no doubt be made to improve the anti-knock quality of gasolines - but this will require several more years.

The fact that significant increases in fuel octane number may be several years off should not in any way impede the progress that the automotive industry can make in designing and producing engines and cars with improved performance and economy. It is felt that a critical examination of the manner in which anti-knock quality is utilized in present-day cars, and of the effect that various design changes may have on anti-knock requirements will point the way to the goal desired by both the petroleum and the automotive industries, as well as the passenger-car operator.



■ Fig. 3 - Investment for 100,000 bbl per day refinery versus octane number of gasoline produced

UTILIZATION OF OCTANE NUMBER

In any consideration of the utilization of fuel, one of the basic factors is the definition of octane-number requirement. This discussion treats the term in the customary manner; that is, the engine octane-number requirement at any condition of operation is considered to be the minimum value providing knock-free performance.

Data obtained in two surveys using a total of 81 cars show, for example, that 80% of the 1946-1947 cars give knock-free operation at the most critical condition with a fuel of 82 octane, while 95% of

TABLE I - EFFECT OF MECHANICAL DESIGN CHANGES UPON FUEL CONSUMPTION AT ROAD-LOAD CONDITIONS

Design Changes	Fuel Consumption, mpg	
	At 20 mph	At 60 mph
I. Standard car 200 cu in. engine 3700-lb (gross) automobile 50 rpm at 1 mph	26	15
II. Reduce rpm		
(a) Overdrive (0.72)	30	17
(b) Automatic transmission	42	17
III. Supercharging (1.5 pressure ratio)		
(a) Lower axle ratio	33	17
(b) Smaller engine	33	17
IV. Increase compression ratio		
(a) Lower axle ratio	37	20
(b) Smaller engine	35	19

Note: The performance in all cases except II (a) is the same as that of the standard car.

the cars are satisfied by an 87-88-octane fuel.

The octane-number requirements at the most severe operating condition have, of necessity, been used by the petroleum industry as the criterion of the quality of the fuel it produces. Requirements at other operating conditions have heretofore had little significance in establishing quality level and have received too little attention. It is felt that a study of part-throttle requirements will chart the course to be followed to attain more efficient utilization of fuel anti-knock quality. For example, one 8-cyl 1946 car, which has a higher than normal compression ratio, gave knock-free operation at speeds up to 40 mph when operated under level-road, constant-speed conditions (on the chassis dynamometer) on zero octane-number fuel. Moreover, 30-octane fuel gave knock-free operation up to 63 mph.

It is evident that the octane number that is sufficient to satisfy the peak requirement of this car considerably exceeds the requirements at other operating conditions.

This fact is even more significant when consideration is given to the amount of operating time the engine demands a fuel meeting the peak octane-number requirement. Several cars were operated on various octane fuels in city traffic, level open road, and over mountainous terrain to determine the percentage of time during which knock-free operation was obtained. A fuel of 70 octane number gave knock-free performance in the 8-cyl test car for 95% of the driving time.

In the effort to improve the efficiency of octane-number utilization, means should not be employed that would adversely affect vehicle performance. Theoretically, a large improvement in economy is possible by reducing engine speed and operating at or near full throttle during road-load conditions without affecting this performance. At the same time much better utilization is made of fuel anti-knock quality.

The question of course then follows: How can such benefits be obtained by practical mechanical design and to what extent will such changes improve economy? Recently, W. S. James, Ford Motor Co., examined this problem quantitatively.[1] Some of his data are summarized in Table 1. A 200 cu in. engine propelling a 3300-lb car with a 400-lb payload was chosen for this analysis. In all cases changes made in the engine or transmission to effect improvements in economy were balanced by other changes to retain the original car performance. Decreasing engine rpm (accompanied by operation at or near full throttle) by the use of a fully automatic transmission gave the largest return, increasing fuel economy from 26 to 42 mpg at 20 mph. High compression ratio (12:1), combined with lower axle ratio, was next best, increasing economy to 37 mpg. At 60 mph the high compression ratio was more effective than the automatic transmission. A combination of a fully automatic transmission and high-compression-ratio engine would, of course, give even greater

1. "Motor Car Trends in Gasoline Economy," by W. S. James. Presented at a meeting of the Natural Gasoline Association of America, Dallas, Tex., April 24, 1947.

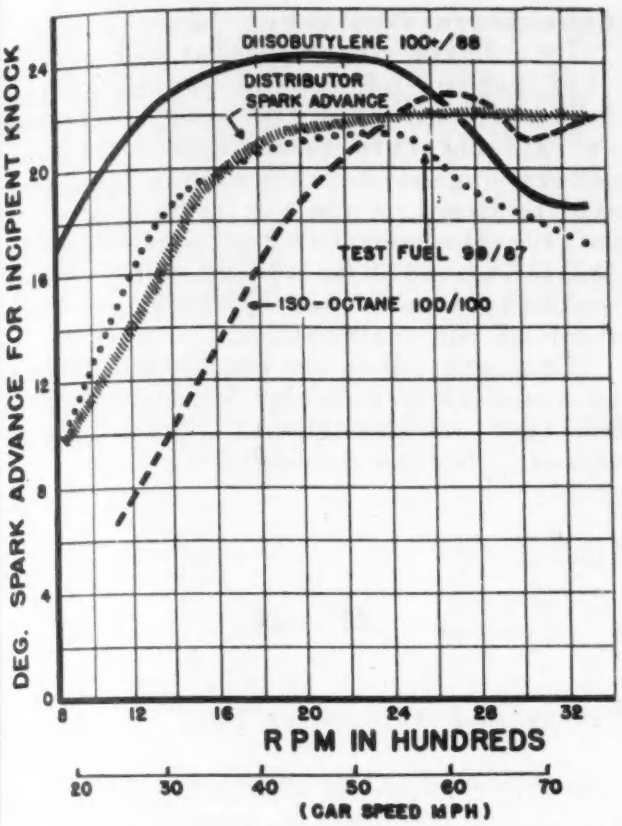


Fig. 4 - Knocking characteristics of fuels for high-compression engine

increases in economy. While it is recognized that the fully automatic transmission is not commercially available, it is generally known that major projects are being conducted by several manufacturers to develop such a unit. The practicability of utilizing a high-compression-ratio, small-displacement engine has been demonstrated by C. F. Kettering.[2]

In considering the effect of these approaches on octane-number utilization, it is evident that the overdrive and automatic transmission, achieving economy as they do through reduction of engine speed and operation at or near full throttle, result in greater utilization of fuel quality. Moreover, relatively small increases in peak octane-number requirement would be expected from these developments. On the other hand, supercharging and high compression ratios are accompanied by large increases in peak octane-number requirement. For instance, the Kettering engine, with a 12.5:1 compression ratio, had a peak requirement appreciably higher than iso-octane, which is 100 in the octane-number scale.

Fuel test data for this engine are shown in Fig. 4 (taken from the Kettering paper[2]). Iso-octane, diisobutylene, and a catalytically cracked stock were tested in this engine for knocking characteristics by the Borderline spark-advance method. Plotting the normal distributor spark advance provides information on whether or not the fuel will give knock-free operation. It can be seen that the catalytically cracked fuel gave knock-free operation over most of the speed range. This fuel, which contained 0.9 ml of tel per gal, had Motor and Research ratings of 87/99, respectively.

If a commercial fuel with characteristics similar to the catalytically cracked fuel shown in Fig. 4 were required as a premium grade, Fig. 2 indicates that it would be impossible to provide enough of the high anti-knock fuel without building considerable new refining equipment at tremendous expense. The situation is not as pessimistic as it appears, however, since certain design modifications can be incorporated in the engine to decrease the peak requirement, such as: (1) a momentary decrease in spark advance at low speeds as the car is accelerated, (2) improvement in the intake manifolding to improve mixture distribution to the cylinders, (3) the use of rich mixtures during high-power operation, as currently employed in aircraft, (4) incorporation of a high-slip coupling (probably hydraulic) to prevent low engine speed at wide-open throttle, (5) improved combustion-chamber cooling, and (6) the use of water injection.

If other considerations necessitate higher peak octane-number requirements, however, it should be remembered these requirements exist for only short periods of time. This characteristic suggests the use of a dual fuel system, which meters two fuels according to demand, one being high enough in anti-knock quality to

[2] See SAE Quarterly Transactions, Vol. 1, October, 1947, pp. 669-679: "More Efficient Utilization of Fuels," by C. F. Kettering.

satisfy peak requirements during full-throttle operation, the other lower in quality for normal cruising operation.

We have been conducting exploratory work to establish the practicability of such an installation. While the work to date has been limited to a relatively elementary combination carburetor and control system, the results have been promising enough to warrant an extensive developmental program. The initial installation demonstrated rather quickly the feasibility of obtaining knock-free operation using 40-octane fuel most of the time in an automobile having a road requirement of 77 octane number. Results of operation with this unit lead to the belief that, using a fuel substantially below the peak requirement for cruising purposes, consumption of the high-octane fuel should not exceed 20% of the total with a commercial dual fuel system, and complete freedom from knock would be provided without a change in car performance.

Test work is now under way in cooperation with a major carburetor manufacturer to develop and evaluate a commercially practicable unit. Inasmuch as several companies have indicated an interest in dual fuel systems, it is expected that announcements of further developments will soon be forthcoming.

The significance of dual fuel systems to high anti knock requirement cars is apparent from Fig. 2. This analysis represents the average of present-day operations producing gasoline. Referring to the curves for commercial gasolines (regular and premium) containing 2-ml tel, the data show that about 20% of 97 Research octane number and 80% of 83 Research rating gasoline could be produced at the present time. Since it is expected that the consumption of the high-octane fuel in a dual fuel system should not exceed 20% of the total, if peak octane requirements are not allowed to exceed 97 Research octane number, it appears possible for modern refineries to take care of the anti-knock requirements of the high-compression cars, *provided a dual fuel system is utilized*. At the same time, the bulk of cars now on the road will be satisfied by the large volume of 83 Research rating fuel, which will be employed for cruising operation of the high-compression-ratio engines.

The choice of the means for greater utilization of octane number at road load and decreasing the peak requirement at full throttle remains with the automotive engine designer. His selection will be based on the engineering approach to give the consumer the performance he desires as well as the economy in fuel consumption so needed in the future operation of our automobiles.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

■ ■

Discusses Difficulties In Use of Dual Fuel Systems

DISCUSSION BY W. E. Drinkard
Chrysler Corp.

IN past years various types of dual fuel systems have been proposed. There is no doubt that such a unit incorporated in a test car will show significantly enhanced performance.

Successful commercialization on passenger cars is a more difficult assignment. If such a system is incorporated in passenger cars at the time of manufacture, a complete reversal in design trends will have to be effected. Further, such a proposal indicates quite clearly that the vehicle must assume an additional and significant cost penalty. Little mention has been made about the problems the refiner must overcome if such a proposal is commercialized. There appear to be many real ones for the refiner, such as distribution, price, keeping it out of 1932 cars, and effecting a satisfactory transition from present marketing to the proposed methods. A study of all factors is in order by both industries before any realistic evaluation of the ultimate possibilities can be made.

TAPERING STEEL Alloy-Element Supply Laid to Unstable World Economics

BASED ON A PAPER* BY

Charles M. Parker

Secretary, Committee on Manufacturing Problems, American Iron & Steel Institute

EFFECT of world postwar economic readjustment on foreign sources for steel alloying elements holds serious implications for the steel industry, especially in the light of an unprecedented steel demand.

What happens to alloy-producing countries wields a vital influence on American steel making because of its dependency on imported materials. Of the 12 principal nonferrous metals used, the steel industry must rely on foreign sources for the bulk of its requirements of nickel, tin, manganese, cobalt, and chromium, and a sizable portion of tungsten and vanadium needs.

At present consumption rates and without imports, according to a report to the President, our domestic supplies of manganese will last 2 years; asbestos and mercury 3 years; platinum, antimony, and tungsten 4 years; vanadium 7 years; bauxite 9 years; lead 12 years; zinc 19 years; and copper 34 years. Supplies of nickel and chromium are virtually exhausted.

World War II upset the prewar foreign-supply applecart and it has yet to be righted.

Early in the war manganese and tungsten shipments from Russia and India, major sources of supply, were interrupted. But development of Cuba as a chief source and increased shipments from Brazil and the African Gold Coast greatly improved the manganese situation. Our normally-limited domestic production also rose.

Loss of British Malaya as a major tungsten source and interruption of Chinese shipments were offset by materials from Bolivia, Argentina, and Brazil. Early war developments also interfered with tin imports from the Far East, cobalt from Australia, chromium from New Caledonia and Oceania, and nickel from Norway and New Caledonia.

These gaps were filled by Bolivian and Belgian Congo tin, Cuban chromium, and Canadian nickel and cobalt.

But such shifts in sources may have far-reaching influences on economies of producing countries. Bolivia, for example, generally ranked third in world tin production. Loss of Oriental sources to Japanese arms boosted Bolivia to first place. Average Bolivian prewar production was 25,000 tons annually; it hit 43,000 tons in 1945. In fact our government built

CONTINUED ON PAGE 47

*Paper "Steel and the World We Live In," was presented at SAE Detroit Section's Mid-Michigan Division, Owosso, Feb. 2, 1948.

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BETTER

FROM PAPERS* BY C. W. Georgi
Quaker State Oil Refining Corp.;

Norman Kendall & R. J. Greenshields
Research Engineer, Chief Research Engineer
Shell Oil Co.;

and W. G. Perriguey
Esso Standard Oil Co.

RECENT clarification of the causes of sludge deposition and corrosive wear in gasoline engines indicates to these authors that the answer to the problem lies in modifying engine designs.

Engine design is only one of the four factors in the problem - design, operating conditions, fuel, and oil - but they are convinced that it is the factor in which the most improvement can be made.

It is clear that by far the most common type of sludge found in vehicles today is the "low-temperature" type due to contamination of the lubricating oil with fuel and products of incomplete combustion which pass the piston rings. "High-temperature" sludge - caused by oxidization of the oil to insoluble products - has been almost eliminated by the removal of easily oxidized oil components and the addition of oxidation inhibitors and detergents.

The way to lick the low-temperature sludge and wear problem is to design the engine so that fuel and combustion products are kept out of the lubricating oil. There are at least three recognized steps the engine designer can take to prevent contamination of the oil:

1. Design the cooling system to operate at temperatures high enough so that fuel and combustion products do not condense on cylinder walls, in the crankcase sump, and on other metal surfaces.
2. Provide positive crankcase ventilation, at idling and low speeds as well as at high speeds, to eliminate volatile substances from the crankcase.
3. Install a filter in the oil system at a point where it will really filter the oil, even during low-temperature operation.

Even more important than these improvements might be changes in the carburetor to provide more efficient fuel-air ratios at idling speeds.

Short-haul, light-load service, where a considerable proportion of operating time is spent in idling, produces low operating temperatures which are more severe with respect to oil contamination, sludge, and wear than continuous heavy-duty high-temperature operation. Low operating temperatures permit raw fuel, partly burned fuel, and the water of combustion to condense on the walls of the cylinder and mix with the lubricating oil. Besides, vaporized fuel and water and other gaseous combustion products enter the crankcase as blowby gases. The very rich fuel-air ratios provided for idling in-

*Georgi paper, "Effect of Engine Operating Conditions on Oil Contamination and Sludge," and Kendall-Greenshields paper, "Deposition and Wear in Light-Duty Automotive Service," were presented at the SAE Annual Meeting, Detroit, Jan. 16, 1948. Perriguey paper, "Some Effects of Climate Upon Automotive Engine Operation," was presented at SAE New England Section on Oct. 7, 1947. Kendall-Greenshields paper will appear in full in SAE Quarterly Transactions.

ENGINE DESIGN Can End Sludge

crease the rate of blowby. And the lower the temperature in the crankcase, the less fuel and moisture blowby is volatilized. Instead of being removed through the breather, these contaminants enter the oil.

Water entering the oil forms an emulsion with the oil. Unsaturate fuel fractions entering the oil may oxidize or polymerize to form insoluble products. When the holding capacity of the oil is exceeded, some of the dispersed combustion products settle in a thin paste. Subsequent higher operating temperatures bake the paste to harder, more adherent deposits, like the "coffee grounds" and coke-like deposits found on oil rings, pump screens, crankcase pans, and valve compartments.

The term "low-temperature" in reference to sludge refers to low engine operating temperatures rather than to low outside air temperatures. Of course, the low engine operating temperatures may be due either to light loads and intermittent operation or to cold weather. However, many engines in light service operate with undesirably low crankcase and jacket temperatures even in warm weather. In such engines low-temperature sludge is a problem the year round.

Much corrosive wear can also be blamed on the water of combustion. Some of the water condenses and combines with carbon dioxide or sulfur compounds released by combustion, forming corrosive acids. The lubricating oil carries the acids along to attack piston rings, cylinder bores, and other surfaces.

The first line of defense against low-temperature sludge and wear is the cooling system thermostat, which controls water jacket temperature. Most current models of engines are factory equipped with thermostats set for the 140-150 F range. When the thermostats are in good operating condition, engine jacket outlet temperatures remain quite constant and reasonably close to the set range. Tests show that this applies over a wide range of atmospheric temperatures and to a variety of vehicles.

Unfortunately, currently used thermostats often stick, and many mechanics have a habit of removing stuck thermostats and not replacing them. With the thermostat omitted, jacket outlet temperatures are much lower - usually only 20 to 50F above atmospheric temperature. At low atmospheric temperature and with engines idling or running at light loads. jacket outlet temperatures in a number of engines were found to be below 100F continuously.

Even with reliable thermostats, inlet temperatures are a problem. Measurements of inlet temperatures showed that with atmospheric temperatures as high as 60 F, inlet water temperatures were below 100 F for a considerable part of the operating time.

Fig. 1 summarizes coolant temperatures as measured in a typical engine running in light-duty service. With no thermostat in the system, coolant temperature rise over inlet temperature varied from a few degrees to 10 deg at the warmest points in the head. With the customary 140-150 F thermostat, temperature rise within the cylinder jacket was of the order of 10 to

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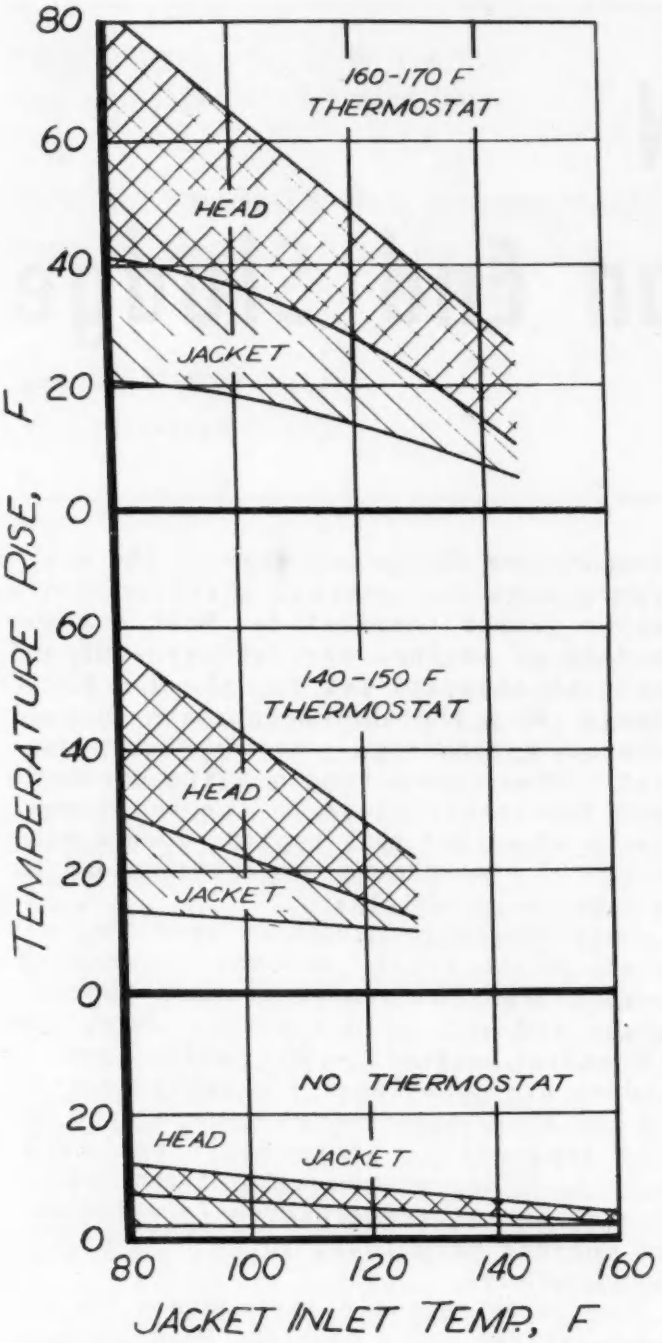

■Fig. 1 - Typical engine coolant temperatures

30 F, and the really warm coolant was concentrated in the head. With a 160-170 thermostat, coolant warm-up in the cylinder jacket was somewhat greater.

These data show the value of a dependable thermostat, set for the 160-170 range. Incorporating such a thermostat is one of the most effective and simplest ways to cut down sludge. Even if the higher thermostat setting requires use of nonvolatile antifreeze in winter, it ought to be worthwhile.

Fig. 1 also indicates that cylinder wall temperatures may be undesirably low, although the dashboard gage, which registers water temperatures at the cylinder head, may register a satisfactorily high temperature. The coolant leaves the radiator and flows to the chambers surrounding the cylinder walls. The coolant temperature is low enough to maintain the cylinder walls at temperatures which may permit condensation. Not until the coolant reaches the cylinder head does it pick up much heat. But then the warmed coolant goes directly to the radiator to be cooled again.

Reversing the direction of coolant flow - so that coolant leaving the radiator would flow to the cylinder head first, then to the cylinder jackets, and back to the radiator - offers possibilities for improving operating temperatures. The coolant would pick up enough heat at the head so that it would not overcool the cylinder walls. Other cooling system improvements under consideration are radiator covers or shutters, variable pitch fans, and radiator bypass plumbing.

Although cooling system temperatures follow a similar pattern in quite a variety of different engine makes, crankcase oil temperature levels vary considerably from engine to engine. For example, crankcase oil temperatures measured in one engine remained in the 100-160 F range, measuring above 130 F much of the time, during operation at 30F outside air temperature. In another engine, crankcase oil temperatures ranged from 70 to 100 F, although the outside air temperature was 60 F. In "cold-crankcase" engines, fuel and combustion products in the crankcase atmosphere do not remain in a gaseous state. Therefore, crankcase ventilation does not eliminate them. Eventually they find their way into the oil.

Tests run to check the effect of variations in crankcase temperature on FL-2 test results have shown that increasing crankcase oil temperatures from 140 to 150 F results in reducing sludge deposits by 50%. (The FL-2 test is used for measuring the tendency of a gasoline to form sludge and varnish.) Increasing the crankcase oil temperature also resulted in a 57% reduction in insoluble resins in the lubricating oil and a 32% reduc-

tion in crankcase dilution.

Designing new engines for higher coolant temperatures and for higher oil sump temperatures will facilitate removal of undesirable crankcase vapors. Old designs can be improved by insulating the crank pan.

CRANKCASE VENTILATION

It is also the engine designer's responsibility to provide for adequate ventilation of the crankcase to draw off fuel and water vapors before they can enter the oil. Wide variations in the amount of reduction in sludge and oil contamination have been reported by various investigators of crankcase ventilation, but they all agree that it is a major improvement. In a series of idling tests with very low engine operating temperatures, positive ventilation at the rate of 5 cfm reduced fuel dilution markedly, eliminated moisture condensation within the engine, reduced the contamination of the oil with insolubles, and gave very little sludge, it is reported. Another series of tests on a single-cylinder CFR engine run at 180 F oil sump temperature showed that as crankcase ventilation increased from 10 to 40 cfh, the amount of sludge decreased from 19 to 4g.

The difficulty with many of the crankcase ventilating systems provided in current engines is that they give practically no ventilation at idling and low speeds, and function effectively only at quite high road speeds. Since the worst contamination by blowby occurs at idling and low speeds, present ventilating systems do not give ventilation when it is needed most. What is needed is a crankcase ventilating system which will give positive airflow in good volume, no matter what the engine speed is.

OIL FILTERS

The controversy over whether oil filters are useful in reducing sludge seems finally to be settled in favor of the filter rooters. At least, tests show that when engines are equipped with filters, the contamination of oil with insolubles and deposition of sludge and lacquer are reduced. Probably some of the confusion over the value of filters has developed because many oil filters do not have a chance to filter. Present practice is to install the filter with a filter bypass on the pressure side of the oil pump. Consequently, under low-temperature operating conditions, and particularly with a low-pressure oil system, the oil in such a system may go through the bypass and never flow through the filter. A better design practice might be to incorporate the filter as an integral part of the engine, locating it at an easily accessible point.

Oil filters are really only a secondary remedy. If coolant temperatures are low and crankcase ventilation inadequate, the insolubles accumulation may build up so fast that the filter cartridge becomes clogged after only a few hours of idling and low-speed operation. Then replacement of the cartridge must be made so frequently - if the filter is to be effective - that the filter becomes economically unfeasible.

Improvement in the design of the carburetor may be as important as improvements in engine design. Carburetors are usually set for fuel-air ratios of 1:13 to 1:15 at high engine speeds, but at idling the ratios go to 1:10 or maybe richer. These extremely rich mixtures result in incomplete combustion and formation of dangerous blowby components. The effect of the increased blowby shows up in idling tests as heavier sludge and lacquer and more oil contamination.

Table 1 shows the relative merits of oil filtration, crankcase ventilation, and leaner fuel-air ratio for a particular engine at idling.

Improved fuel metering systems capable of maintaining efficient fuel-air ratios over a wide range of engine speeds would be one of the most effective cures for sludge and wear troubles.

Not much can be done to the other factors - engine operating conditions, fuel, and lubricating oil - to decrease sludge formation.

Low-temperature operating conditions will prevail as long as most passenger cars and light trucks are engaged in city driving at low load and with frequent idling, unless, of course, changes are made in the design of the cooling system. The only other controls on operating conditions are in the operator's hands; he

Table I - Effect of Engine Modifications on Oil Contamination - 48 hr Engine Idling Tests

Jacket inlet temperature, 120 F; crankcase oil temperature 125 F;

Jacket outlet temperature, 130 F; 600 rpm no load.

	Stock Engine Set-Up	Oil Filter Installed	5 cfm Forced Ventilation	Fuel-Air Ratio of 1:14
Oil Drain Analysis				
Fuel Dilution,%	19.0	21.0	3.0	3.6
Total Insolubles,%	3.0	0.2	1.0	0.8
Lead Salts, Soot, etc.,%	2.3	0.1	0.8	0.6
Resins,%	0.7	0.1	0.2	0.2
Engine Condition				
Sludge Deposits	Heavy	Slight	Slight	Slight
Moisture Condensation	Heavy	Heavy	Nil	Nil

can keep the engine in good condition by good maintenance and by replacement of worn piston rings and cylinder liners, and by tightening cylinder heads and inspecting gaskets for leaks.

As for fuel, there is some evidence that engine cleanliness could be increased slightly by treating fuel to remove the unsaturated reactive materials. However, removal of unsaturates does not appear to be worth while for several reasons. First, it has been shown that removal of all unsaturates fails to produce a perfectly clean engine. The reactive unsaturates evidentally account for only part of the deposition. Much of the deposition is derived from products of partial combustion and breakdown of the fuel which enter the crankcase. These products can be kept out of the crankcase only by design changes. Second, treatment of gasoline to remove unsaturates is expensive. Third, where engine deposition has been reduced to the minimum under low-temperature operating conditions by drastic treatment of the fuel, it has been found that corrosive wear is increased to a considerable extent due to the absence of the protecting lacquer films on the metal surfaces. No changes in the fuel can be made to reduce corrosive wear.

Some people concerned with the problem of sludge have suggested that more volatile fuels would give less sludge because fuel vapor passing into the crankcase would be less likely to condense and pass into the oil. Experiments have not confirmed the idea; increasing the volatility of the fuel does not offer any appreciable measure of improvement in deposition, as long as the ASTM 95% distillation point is not above about 390 F.

It is difficult to determine the effect of sulfur on deposition because high sulfur content in gasoline is associated with high unsaturates content, but there is no reason to believe that removal of sulfur would result in cleaner engines.

The amount of sulfur present in commercial gasolines is also too small to influence wear significantly, especially since the surfaces most susceptible to attack by sulfur compounds are also most likely to be protected by lacquer.

Any future improvements made in lubricating oil undoubtedly will be in the direction of increasing the ability of the crankcase oil to hold in suspension the degradation products of the fuel or to neutralize the corrosive acid materials formed from the products of combustion. Recently, additives have been developed which have a detergent action; just as soap can hold particles of dirt in suspension in water, detergent added to oil can keep insolubles in suspension so that they do not settle as sludge. However, the very best detergents have a limited capacity for holding blowby insolubles and contaminants in dispersion in motor oil. A detergent can't replace a shovel when blowby contamination of the oil reaches the proportions found in many light-duty, intermittent operations.

Certain synthetic oils, or petroleum oils containing special additives, which have a solvent action on sludges, varnishes, gums, resins, and moisture, have been used as a means of preventing the accumulation of low-temperature sludge. They do reduce the accumulation, but certainly an oil containing more than several percent of contaminants, although the contaminants are held in dispersion, is not performing its lubricating function properly.

When sludge troubles were first encountered, they were blamed on the lubricating oil. Some of the blame was de-

CONTINUED ON PAGE 62

DIESEL RESEARCH Aided by Exhaust Condenser

BASED ON A PAPER* BY

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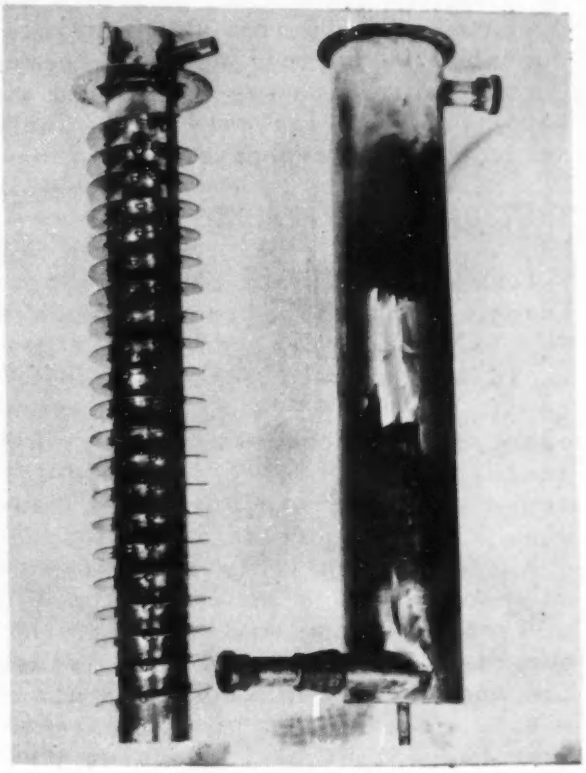
DIESEL-engine research is being aided by a newly developed shortcut for evaluating the end products of combustion. A condensing system is used to cool and condense the entire exhaust from the engine, so that cumulative amounts of small fuel fractions (which would normally elude the investigator of single combustion cycles) can be collected, weighed, and analyzed. Results are obtained quickly, with the burning of very little test fuel, as compared with earlier test methods.

APPARATUS

The apparatus consists of a large condensing system, which cools the exhaust down to -10 to 0 F. The exhaust is piped from the engine to a surge tank to reduce pressure pulsations. Then it passes through two large stainless-steel condensers.

As shown in Fig. 1, each condenser



■Fig. 1 - Stainless-steel condenser used in exhaust condensate experiment - condenser well has spiral fin attached for increasing cooling area

*"Combustion Characteristics of Diesel Fuels" was presented at the SAE Annual Meeting, Detroit, Jan. 15, 1948.

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consists of an inner well with a spiral cooling fin that fits into the outer tank so that the gases have to spiral around as they pass through the condenser.

The water vapor resulting from combustion is condensed and collected on the surfaces of the condensers (which are cooled by a mixture of dry ice and naphtha in the well). Some of the water runs out of the first condenser into a drain bottle, while the remainder freezes on the cold surfaces. The gases also pass through two small condensers of similar construction, although by this time they have lost most of the water and heavy vapors. A small amount of material collects on a cloth filter at the outlet of the condensing system. The solid material is collected primarily in the surge tank and the first two condensers, although a little may continue through the system to the filter to be collected there.

Two water-cooled precombustion-chamber engines were used in the tests. The 3 3/4 x 5 in. engine (operated at 1200 rpm) had its combustion chambers altered somewhat from the standard engine. The 4½ x 5½ in. engine was standard and was operated at 1100 rpm. Both engines were operated at normal jacket temperature. Normal aspiration was maintained and exhaust pressure was only a few inches of water above atmospheric.

TEST DATA AND RESULTS

Test data indicate that in a normally loaded engine the liquid component of the exhaust decreases with increased fuel: air ratio or load. The solid content, however, either remains nearly constant or increases slightly with an increase in fuel: air ratio until the smoke point of the engine is reached, when a large increase in solids occurs.

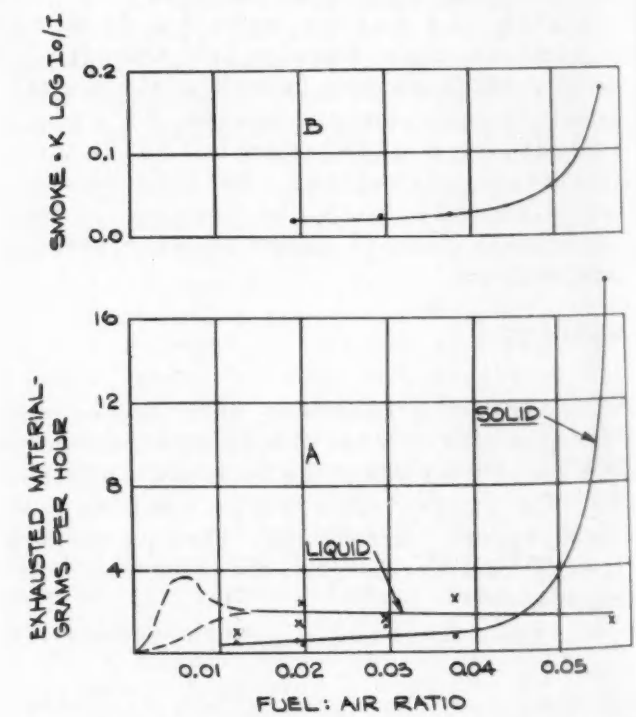
Fig. 2A shows the weight of material collected per hour as a function of fuel: air ratio for the small engine. The dotted lines indicate possible values, if the data had been taken to such small ratios. The weight of solids was less than the weight of liquids up to 0.045 fuel: air ratio. Above this value the exhausted solids exceeded the liquids. The smoke point was reached at 0.06 fuel: air ratio. In Fig. 2B smoke is plotted in terms of $k \log I_o/I$, where k is a constant depending on the smokemeter and engine conditions, I_o is the smokemeter reading with no smoke, and I is the reading with smoke passing through the meter.

The large engine exhausted more solid material than did the small one for corresponding fuel: air ratios, although the amount of liquid exhausted was less.

Further tests were run with samples of eight different fuels. Some of the characteristics of these fuels are given in Table 1. These tests were run at 65 bmep, which was near enough to the smoke point of some of the fuels, so that differences in exhausted materials were emphasized.

The amount of carbon deposited was essentially the same except for the blends of cetane and alpha methyl naphthalene and the 29-cetane catalytically cracked fuels, which produced more carbon under the same conditions. Changes in engine design and timing, however, could alter these results.

Good correlation was obtained between the amount of carbon exhausted per hour and the cetane number of the fuel. The ignition delay and subsequent burning



■Fig. 2 - Liquids and solids exhausted from 3 3/4 x 5 in. engine per hr and measured smoke

TABLE I - PARTIAL DATA FOR TEST FUELS

Fuel No.[a]	1	2	3	4	5	6	7	8
ASTM Cetane No.	41.0	54.0	46.0	40.0	40.5	29.0	52.0	83.7
Distillation, F								
Initial	417	350	372	205	458	419	337	352
End Point	631	660	636	222	541	586	634	622
Gum (General Motors), mg per 100 cc	43.4	6.2	52.4	1.0	13.8	-	-	-
Conradson Carbon Residue (10%), %	None	0.011	None	-	0.058	0.08	0.025	0.11
Ash in Residuum, %	-	-	-	-	-	None	0.006	0.02
Neutralization No.	-	-	-	-	-	0.08	0.09	0.45
Corrosion (Copper Strip, 212 F)	No. 1 strip	O.K.	No. 2 strip	O.K.	O.K.	Pass	Pass	Pass
Total Sulfur,%	0.219	0.25	0.199	0.0097	0.87	0.20	0.12	0.04

[a]Fuel No. 1 - Blend - primarily catalytically cracked (Standard of Ind.)
Fuel No. 2 - Straight-run diesel fuel - Midcontinent (Sinclair)
Fuel No. 3 - 50-50 blend of Nos. 1 and 2 (Standard of Ind.)
Fuel No. 4 - N-heptane, iso-octane (Sinclair)
Fuel No. 5 - Cetane-naphthalene blend (Sinclair)
Fuel No. 6 - Catalytically cracked stock (Navy)
Fuel No. 7 - Straight-run 702-E Specification (Navy)
Fuel No. 8 - Fischer-Tropsch (Navy)

period undoubtedly affect the amount of solids exhausted. A long delay in the precombustion-chamber engine would permit the injection of a large quantity of fuel before ignition, which would then subject the fuel to the high temperatures and pressures of initial burning with limited oxygen before transfer to the main combustion chamber. Thus, considerable carbon would be produced before reaching the greater oxygen supply in the main chamber, and the shorter overall burning period would not permit all the carbon to be consumed. This would, however, cause high turbulence in the main chamber. A short ignition delay would start the fuel transfer to the main chamber early in the cycle. Thus the fuel would be forced out of the precombustion chamber during the injection period and less would be subjected to high temperatures and pressures in the limited oxygen supply. This would reduce the amount of carbon produced and would permit a longer burning interval.

The blend of cetane and alpha methyl naphthalene differs from the other fuels in that it is a blend of commercial cetane, which is a fairly pure paraffin, and the commercial aromatic compound alpha methyl naphthalene, and it has almost four times as much sulfur as the others. Paraffins break down most easily when subjected to high temperatures and pressures, but under these conditions the aromatic type has a greater tendency to form coke, which is hard to burn, and which may explain why it produced more exhausted solids than did the other 40-cetane fuels.

Smokemeter readings for the fuels were plotted as a function of fuel: air ratio on the large engine, as shown in Fig. 3. Fuel: air ratios corresponding to 65 bmep on the small engine are indicated on the smoke curves for the large engine. The figure also gives smoke values for the small engine for each fuel for the fuel:

air ratio at 65 bmep.

It is difficult to compare smoke from one engine to that from another, but at comparable fuel: air ratios, a definite correlation was observed between the two engines.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

DISCUSSION*

The increased understanding of the combustion process that is possible with the author's very practical method of measuring exhaust products will bring greatest gains as far as engine life (and to a lesser extent exhaust conditions and noise) are concerned, whereas power and economy cannot be affected to any great extent.

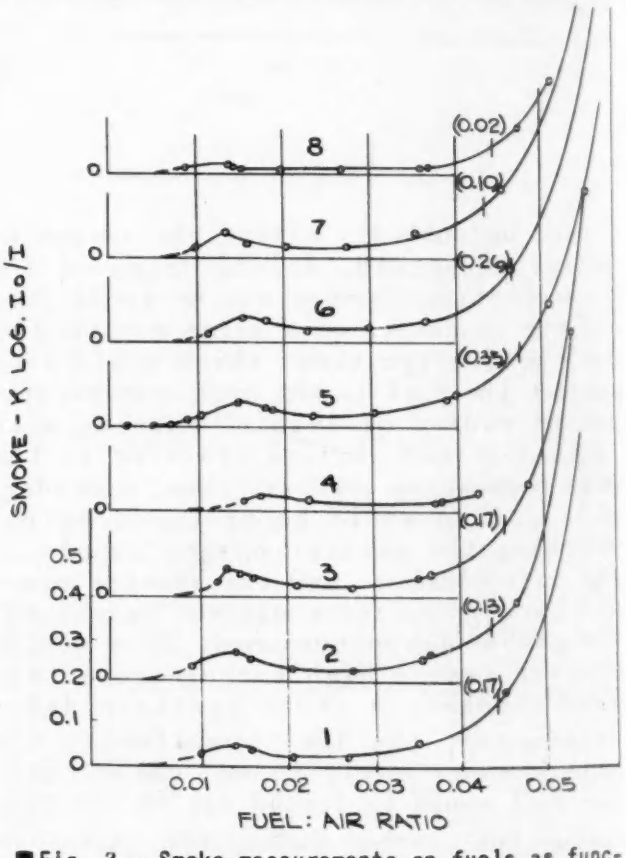
A study of the author's results shows that the unburnt fuel collected per cycle from the exhaust is too small to be responsible for a loss in economy or performance.

Even though his figures do not include the unburnt carbon that shows up as deposits or lubricating oil contamination, other tests indicate that these losses are extremely small. Thus it seems that the total amount of fuel wasted is not an impressive factor, especially when one considers that about 55% of the fuel energy is lost through cooling, exhaust, heat, and radiation.

Engine life, however (in which there is still plenty of room for improvement, as far as present high-speed engines are concerned), is greatly affected by the deposits from unburnt fuel. For instance, if the small quantities of unburnt fuel obtained by the author are multiplied by the 80,000 lb of fuel used in an average truck engine in 60,000 miles, you begin to get an idea of the real menace that these unburnt materials represent.

In this phase of combustion research little help can be expected from investigations of individual combustion cycles, for the minute fractions of unburnt fuel in each cycle are not affecting power or consumption, pressure conditions, flame temperatures, or normal exhaust gas analyses to any measurable extent. The author's method is a shortcut that enables cumulative values of these small fuel fractions to be measured.

It is now important to follow this work up with more studies of the behavior of different fuels when burnt under the ad-



■ Fig. 3 - Smoke measurements on fuels as function of fuel: air ratio for 4¼ x 5½ engine - numbers at right give smoke values from 3 3/4 x 5 in. engine

*Based on discussion by H. M. Gadebusch, Detroit Diesel-Engine Division, GMC.

TABLE A - SMOKE PERFORMANCE

(Expressed in percentage to best fuel)

Fuel No.	Description	%
4	Blend of N-heptane	100
8	Fisher-Tropsch	112.5
5	Blend of cetane	238
6	29-cetane (Navy)	238
7	Navy 702-E	262
3	Blend of catalytically cracked and straight-run stocks	262
2	Straight-run Midcontinent	275
1	Catalytically cracked	287

verse conditions of reduced loads and speeds prevailing in most types of service during a large part of operating time.

Smoke is closely related to engine life, for engines continuously operated under smoky exhaust conditions, whether the smoke be black, white, or blue, automatically have reduced life.

Black smoke is a mixing problem that reaches its full importance only at high engine loads, as shown by Fig. 3.

At the highest comparable fuel: air ratio of 0.0425, the eight test fuels range as given in Table A.

It may be seen that the first two fuels are outstanding in their smoke performance. The blend of iso-octane and normal heptane has a cetane number of 40, while the synthetic material has a cetane number of 83.7. Apparently offsetting this large difference in cetane number is the low boiling range of the heptane-octane blend, which ends at 222 F as against 622 F for the Fischer-Tropsch fuel.

The obvious conclusions would be that (a) both boiling range and ignition quality combine to produce the smoking characteristics of diesel fuels, and (b) reduction of boiling range appears to be the most effective remedy against black smoke.

Steel Alloying Elements

CONTINUED FROM PAGE 37

a smelter in Texas City to refine Bolivian concentrates.

With richer Oriental mines now swinging back into production, Bolivia fears the consequences. To strengthen her position, Bolivia signed an economic agreement with Argentina to deliver 8000 tons of tin to Argentina. This amount will be taken from the United States quota - previously set by Bolivia.

Yet our tin needs have increased rather than diminished, despite savings made by the electrolytic timing process. So we must turn to more distant sources - Malaya and the Netherlands East Indies. Prominent mention is being made of both these countries in current Washington discussions of stockpiling in connection with the Marshall Plan.

Marshall Plan countries and their colonies have been supplying United States stockpiles with only $17,000,000 worth of material a year. It's proposed to raise this to $172,000,000.

But difficulty is being experienced in balancing the Plan because many of the world's chief sources of strategic materials lie outside of Marshall Plan countries. Russia currently is supplying one-third our manganese, half of our chromium, and more than half of our platinum. Spain provides two-thirds of the world's mercury. India produces 75% of the block mica. China, one of our main tungsten sources, now sells most of it to the Soviet Union.

Because the steel industry is the largest consumer of many minerals, it is vitally concerned with these world problems that must be solved. Imported materials consume a large part of the steel sales dollar.

(Complete paper on which this article is based is available from SAE Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

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BASED ON A PAPER* BY

Miller A. Wachs
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TESTING HI

HELICOPTER manufacturers have devised several bench tests of their transmission systems which simulate many hours of flying time in a few days of testing time. But the supplementary tie-down endurance tests as prescribed now by the CAA, Army, and Navy take an unneccessarily long time to run.

Sikorsky Aircraft has developed a method of bench testing clutches which duplicates 300 hr of wear in 66 hr of testing time. The SAE helicopter subcommittee has recommended a method of testing main and auxiliary rotor transmissions in which 100 hr of test time at full rated power and speed is equivalent to 250 hr of normal flight time. Another accelerated bench-test method for auxiliary rotor systems is being used to check critical speeds of the drive shaft and endurance of transmissions, couplings, and universal joints.

The CAA, Army, and Navy have established tie-down endurance tests to insure that helicopters shall give good service. The CAA test takes 100 hr; the Army test, 150 hr; and the Navy test, 500 hr. All three tests require operation at several combinations of speed and power - presumably on the theory that this will show up any difficulties arising from torsional resonances in any part of the operating speed range. However, torsional resonances are not a problem in helicopter drive systems. Therefore, endurance could be tested just as well - and faster - by operating at maximum speed and power for a shorter period.

Both bench tests and tie-down endurance tests are essential steps in overall helicopter design and development programs. The first step in the process is careful design based on analysis and experience. The second and third steps are the bench and endurance tests. Elements of the helicopter - particularly those operating in rotary or oscillatory motion or subjected to alternating loads - are bench tested individually. Tie-down endurance tests test the complete helicopter on the ground. The fourth step is accelerated service flight tests, and the last step is continuous checking of field service records obtained from customers in order to discover any weaknesses which did not show up in the test program. Each step supplements the others, and no step can be omitted.

Good bench and endurance tests disclose weaknesses in the design with a minimum expenditure of time and money.

TESTING CLUTCHES

Sikorsky Aircraft uses the setup shown in Fig. 1 to test the mechanical centrifugal clutches currently employed in Sikorsky helicopters. Besides pointing the way to many refinements in clutch design, this setup has been used to compare the relative wear of friction materials and to determine the rate of wear versus total area of friction material. In the power train of the test setup are an electric motor, the clutch, a free-

*Paper "Accelerated Testing of Helicopter Drive Mechanisms" was presented at SAE Philadelphia Section, Dec. 10, 1947.

HELICOPTER DRIVES

Bench Techniques Surpass Tie-Down

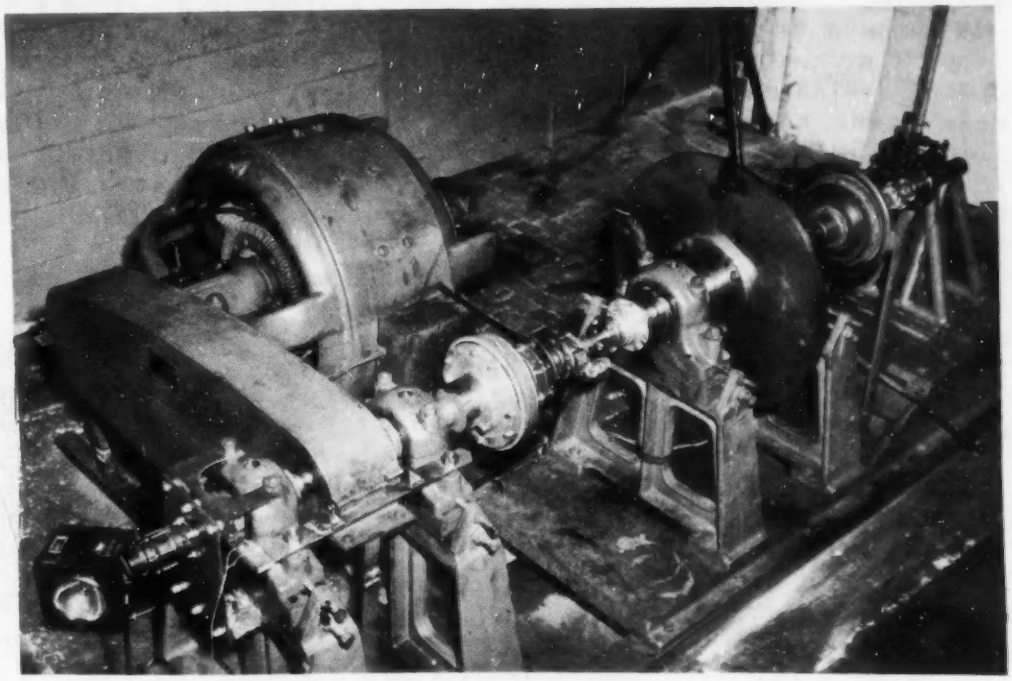

Fig. 1 - View from driving end of clutch test setup

wheel unit, a torque meter, the flywheel, and a brake.

The 55-hp, 750-1500 rpm variable-speed, d-c motor is connected to the driving member of the clutch by a 1½:1 step-up silent chain drive. The clutch shoes are spring retained in such a way as to engage automatically when the driving member is accelerated to a predetermined speed between engine idle and operating speeds. Power from the clutch is transmitted through the free-wheel unit to the torquemeter, which is a Baldwin Southwark SR-4 strain gage (type AR-1 Rosette) with slip rings mounted on the shaft.

Following the torquemeter in the power train is a flywheel whose inertia is the same as the equivalent inertias of the rotors to be driven by the clutch; that is the flywheel inertia is equal to the inertia of the rotors divided by the square of the gear ratio of the reduction gearing between clutch and rotors. The drum of an automotive-type brake is connected to the flywheel. The braking elements of the brake are mounted stationary with reference to the bed plate. Pressure of shop air is used to actuate the brake. Shop air for cooling the brake enters a thin torus surrounding the

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brake and leaves through holes at the inner diameter, being directed against the brake.

One electric tachometer is connected directly to the clutch driving member, and another is driven by sprocket and chain from the clutch driven member.

The test setup is instrumented to repeat automatically a predetermined cycle of operations. An electric timer with adjustable cycle stops and appropriate relays times the cycles. An electric cycle counter keeps track of the number of clutch engagements. Time required to accelerate the flywheel is checked with a stopwatch at intervals throughout the test.

A cathode ray oscilloscope modified to respond to d-c current indicates rpm of clutch driven member versus flywheel accelerating torque. The horizontal deflection is proportional to rpm, and the vertical deflection is proportional to torque as indicated by current variations measured by the strain gages of the torquemeter. Using a long-persistence type of cathode ray tube makes it possible to trace typical indicator cards of rpm versus torque before the light has faded.

The instrumentation controls three steps:

1. Speed-up of the electric motor from idle to clutch-engaging speed. This draws the clutch driven member and the flywheel from zero speed to the speed of the clutch driving member.
2. Slow-down of the electric motor to idle speed again. Then the flywheel overruns the clutch and the driven member of the centrifugal clutch disengages from the driving member.
3. Application of the brake to bring the flywheel and clutch driven member to rest. This step is begun only after the flywheel has coasted for a short time.

A complete three-step cycle can be completed in 4 min. At this rate, the wear which would result from about 300 hr of flying can be duplicated in about 66 hr of test time, or approximately 9 working days with one attendant.

With the automatic controls cut out, the setup is also used to determine breakaway torque available at 100-rpm increments from engaging speed up to operating speed. Because the motor's 55 hp is inadequate to break away a full complement of shoes at rated speed, tests are conducted with only two shoes. The breakaway torque with a full complement of N shoes is taken to be N/2 times the value obtained for two shoes.

The wear of the shoes is measured and recorded periodically, and average wear per engagement is determined.

A subcommittee of the SAE helicopter committee has worked out a bench test for testing main and auxiliary reduction gears. The test method is outlined in SAE Aeronautical Information Report No. 14. It calls for static, or slow rotation, deflection testing to determine bearing and gear alignment and dynamic testing at rated power and speed. Dynamic testing of main transmissions is accomplished at very small expense of power by preloading one transmission against another so that only friction horsepower need be supplied to operate the transmissions at rated speed. The same idea can be applied to angle gear boxes by connecting them in a four-square arrangement.

TESTS OF AUXILIARY DRIVES

Auxiliary drives are bench tested for critical speeds of the drive shaft and for endurance of transmissions, couplings, and universal joints.

The drive shaft critical speed can be checked by driving from a low-power variable-speed motor. The whole speed range from zero to 115% of maximum operating speed should be free from resonance.

The complete auxiliary-rotor drive system can best be checked by mounting everything aft of the auxiliary rotor drive take-off and driving from an electric motor. Fig. 2 shows how Sikorsky mounts the assembly outside a control shed. The storm fence provides some protection against the effects of rotor failure. Inside the shed are the electric motor and a control panel with the pitch control and the indicators for pitch, torque, thrust, and rpm. The pitch can be cycled as many times as desired, making it possible to endurance test the rotor control system, as well as the rotor and drive components.

The CAA, Army, and Navy have apparently based their tie-down endurance tests on engine testing practice, where the whole

operating range is explored to reveal any speeds critical for torsional vibration.

So far, helicopter drive systems have not developed torsional vibration difficulties. In most systems, the drive shafts are sufficiently flexible because of their length to put most orders of torsional vibration below the operating apparently do not build up to large amplitudes in the fully articulated blade configuration, because of the damping provided in the vertical hinges. Complete reversal is impossible because of the free-wheel unit.

What the test should be measuring is ability to withstand other-than-torsional-vibration stresses and amount of wear. In the transmission system, these factors could be determined in a minimum of time by continuous operation at maximum possible speed and power. And, provided that analysis of bench tests had demonstrated complete absence of dangerous torsionals in the operating range, type testing could best be done by continuous operation at full rated power and speed.

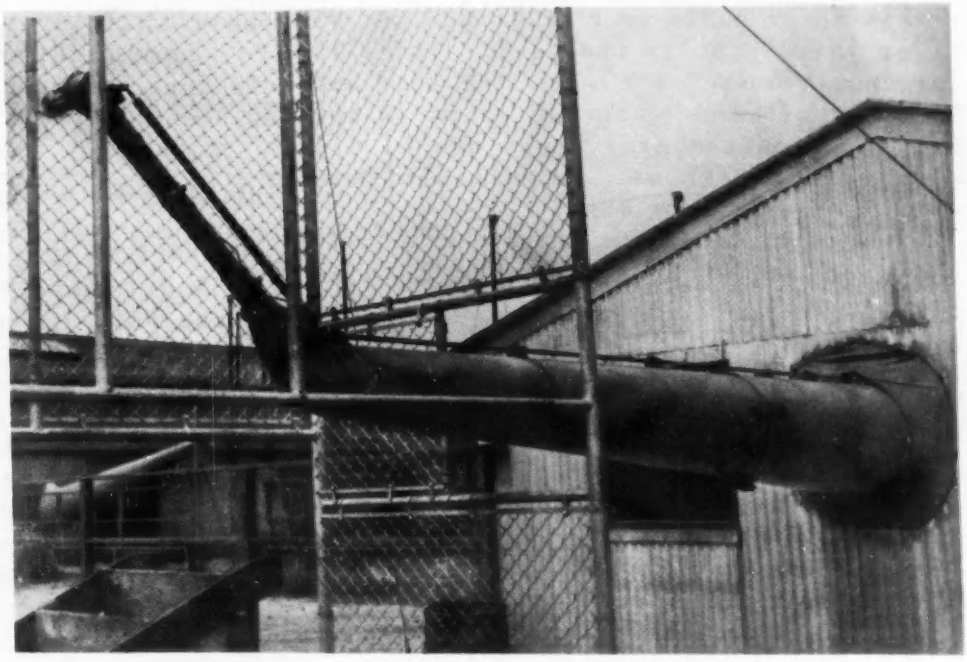
The CAR Part 06- Rotorcraft Airworthiness regulation, paragraph 06.420, calls for 60 hr at maximum continuous engine speed and maximum continuous engine power, 10 hr at take-off power and speed, and 30 hr at 90% speed and 75% power. The Army Air Forces Specification 41101 calls for 55 hr at rated power and speed and 95 hr under 10 other conditions of power and speed ranging in steps from idle speed and power up to 97% rated speed and 98% rated power, and also 110% rated speed and 100% rated power. The Navy requires 500 hr of flight tests or a total of 500 hr of flight and ground tests.

TESTS COULD BE SPEEDED

Assuming life to be inversely proportional to rpm and to the cube of load, the CAA 100-hr test is equivalent to 82 hr at rated power and speed, and the AAF 150-hr test is equivalent to 92 hr at rated power and speed. In wear on the transmission system, the Navy 500-hr test is equivalent to only 200 hr of continuous running at rated power and speed on the ground.

If tests were run at rated power and speed instead of according to the present specifications, 18 hr of running time could be saved on the CAA test; 58 hr on the AAF test, and 300 hr on the Navy test.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)



■ Fig. 2 - Installation for tail rotor endurance test

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WESTERN FLEET MEN

BASED ON A PAPER* BY **Ted V. Rodgers**

Chairman, Board of Directors,
American Trucking Association, Inc.

GEOGRAPHIC and climatic peculiarities of Western trucking as well as state restrictions force fleet men to seek relief from troubles such as inadequate brakes, poor steering control, exhaust noise, objectionable diesel smoke, insufficient power, and payload limitations.

One real problem in the 11 Western states is the compromise between level road speeds and grade-ability on mountain slopes. While grades in the Rocky Mountains are not much different from those in the East, they are much longer. On many routes carriers report grades of 5 and 8% for extended distances. And mountain passes vary in altitude from 5000 to 11,000 ft.

Trucks may run on continuous grades for as long as 20 miles. This means regular road operation on grades, not just relatively short pulls over hills and out of river valleys as in the East. It calls for enough horsepower under the hood and a number of closely-spaced gears in the transmission to permit best use of all available horsepower to maintain road speed for an hour or more.

A number of fleet operators queried say they want about 20 mph on the 5 to 8% grades and 40 to 55 mph on level roads. They don't want truck designers to dream too much about two engines in a truck or tractor - using two engines on grades and one on the level. They do want manufacturers to provide horsepower required for level-road speeds for a 70,000-lb gross weight plus a reasonable acceleration reserve, in a single engine.

For optimum performance, diesel engines have a relatively narrow range. To keep gear steps close enough together to prevent overspeeding or lugging to the detriment of the engine or road speed, the transmission must have more than five forward speeds. Ten or more speeds in the transmission give the driver a gear selection making for maximum road speed with engine rpm for maximum horsepower.

Most currently available compound transmissions require double shifting to select correctly the proper gears for varying grade conditions. This double shifting is difficult and dangerous because it frequently requires two-hand manipulation of two shifting levers. A power-shifting mechanism now available for compound transmissions does not eliminate the double shift for selecting adjacent gears.

BRAKING PROBLEMS

Because of grade conditions, brakes on large vehicles and combinations used on the West Coast must perform well in two respects - stopping ability and retarding ability. Although adequate in stopping performance, present brakes act too slowly on 60-ft combinations. Present brakes will not stop a 60-ft rig in 30 ft from 20 mph, measured from the point where the brake pedal is first depressed. This slow-stopping performance is a real problem in the face of unrealistic formula of a 30-ft stop at 20 mph in

*Paper "Transportation Problems in the 11 Western States" was presented at SAE Detroit Section, Feb. 16, 1948.

Voice Needs in Truck Design

regulations and safety propaganda. Power brakes don't do the job because of operational lag in the system. There is great need for design improvement to reduce lag in power brakes.

Mountain braking also demands retarding action on long grades. A device using other than wearing brake linings to produce retarding effect is called for. Although both electric and hydralic retarders are being developed, present configurations add considerable weight. Western operators are not entirely in agreement on the need for a retarder. For this reason it seems that present brakes do a reasonably acceptable job on five or six-axle combinations as regards retardation on grades.

STEERING CONTROL IMPORTANT

Braking ties into the steering problem on mountain roads with their many curves and shelves. Continuous need for steering control brings considerable opposition to front-wheel brakes from fleet operators. They feel overbraking the front wheels locks them and takes steering control out of the driver's hands. The vehicle continues to travel in a straight line in the direction it was headed when the front wheels first locked.

Hardly any five and six-axle combinations are operated in the Rocky Mountains with front-wheel brakes in action. At odds with the Interstate Commerce Commission over this matter for many years, the trucking industry needs help from vehicle manufacturers.

Western geography also makes for long runs. Regular route distances in coastal to inland services are 400 to 600 miles. For routes from the West Coast to Chicago a truck may pass over 1000 miles of mountainous terrain.

A reasonable figure for operating mileage is 200 miles per 10-hr driving trick. A 400-mile run is really 800 miles round trip and may involve as many as four different drivers over a two-day period on one vehicle. For this reason there's a real need for uniform driver control mechanisms for trucks and tractors. On relay operation a driver has little time to familiarize himself with the peculiarities of a particular vehicle.

And let's not alibi equipment failures in this kind of operation onto driver abuse. What more can you ask of a driver if he keeps within speed limits and has no accidents? For example, there's little you can expect of the driver with 70,000 lb gross on a grade and in intermediate gear, with wide-open throttle making 18 mph. All components are being worked to capacity; it's not the driver's fault if an inadequately-designed part fails.

Most important to the fleet operator on long-haul operations is reliability. Road failures and break-downs are extremely costly; original vehicle cost is secondary.

The Western carrier greases his vehicles just about every trip. If the round trip is 1200 miles, the truck can be serviced only once during that time. Such lubrication schedule means a grease job every second to fourth day. For this

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TABLE I - MAXIMUM SIZES AND POSSIBLE [1] GROSS WEIGHTS UNDER STATE LIMITATIONS OF ELEVEN WESTERN STATES

STATE	OVERALL LENGTH - IN FT				MAXIMUM GROSS LOADS - IN LB			
	Single Truck	Truck Full-Tr.	Tractor Semitr.	Semitr. Only	Axle Load	Truck Full Trailer	Tractor-Semi Single Axle	Tractor-Semi Tandem (2)
Arizona	35	65	65		18,000	80,000	44,000	68,000
California	35	60	60	35	18,000	76,800	44,000	68,000
Colorado	35	60	60	35	18,000	76,000	44,000	68,000
Idaho	35	65	60	40	18,000	68,000	42,000	68,000
Montana	35	60	60		18,000	73,280	44,000	71,900
Nevada	[3]N.S.	[4]N.R.	N.R.		18,000	76,800	44,000	69,600
New Mexico	40	65	65		18,000	70,500	44,000	65,200
Oregon	35	60	60	35	18,000	71,250	44,000	63,750
Utah	45	60	60	45	18,000	79,900	44,000	72,250
Washington	35	60	60	35	18,000	71,250	44,000	63,750
Wyoming	40	60	60		18,000	72,250	44,000	65,800

(1) Gross weight values assume 8,000 lb on front axle.
(2) Formula computation based on 3-axle tractor and tandem axle semitrailer.
(3) Not specified.
(4) No restrictions.

reason the operator wants servicing operations made as simple and as quick as possible. The trucking industry could save money and get more use of its vehicles if lubrication and inspections periods could be extended safely.

RUN WEATHER GAMUT

Just as problem-creating as the West's geography are the great climatic variations in the Rockies. For example, in some parts the same carrier may encounter one or more or the following conditions eight months or more of the year:

a. Summer and winter weather each day;
b. Rain and desert weather each day;
c. Just rain;
d. No rain.

The summer-winter climatic combination probably is the toughest. A truck will start near the seacoast in essentially summer weather. It will run into winter conditions in high passes and spring conditions in mountain valleys. The same variations are encountered on the return trip.

Rain and desert operation in the lower southwestern regions probably are next most severe. Here operation may not be too tough if engine cooling systems are adequate; but dust and grit do considerable damage and maintenance costs are high. Many Western carriers wash and lubricate their units every trip to keep grit out of moving parts.

Two of the biggest faults these operators find with present vehicles, which hurt public relations, are excessive exhaust noise and diesel smoke.

Engine exhaust noise - common to diesel, gasoline, and liquefied-petroleum gas engines - is highly objectionable, particularly when passing through a small town at night or when a large engine accelerates under load.

Three things must be considered in mufflers for heavy-duty-equipment. First, need exists for an accurate noise-measuring technique so that a noise-limit standard can be established. Second, these large engines operate at full load on grades for hours at a time. The muffler must be designed so there is no

perceptible reduction in power output; otherwise the muffler will be discarded.

Third, it must be remembered that many of these trucks operate between 100,000 and 150,000, or 5000 to 6000 hr per year. Operators who spend $10,000 to $12,000 for a vehicle believe a muffler should last at least one year and do a good job.

A truck costing this much deserves something more than a $3.79 can. Original equipment mufflers in Western service have failed completely in as little as three weeks.

Alloy steels, ceramic coatings, and adequate capacity have not been touched in heavy-duty muffler design.

Smoke from diesels in narrow valleys would put the worst coal-burning locomotives to shame. It's more than an operating problem. Some of it comes from easy adjustment features which permit fiddling by drivers who think smoke means power. Injectors should be made foolproof so that accurate shop adjustments can't be tampered with.

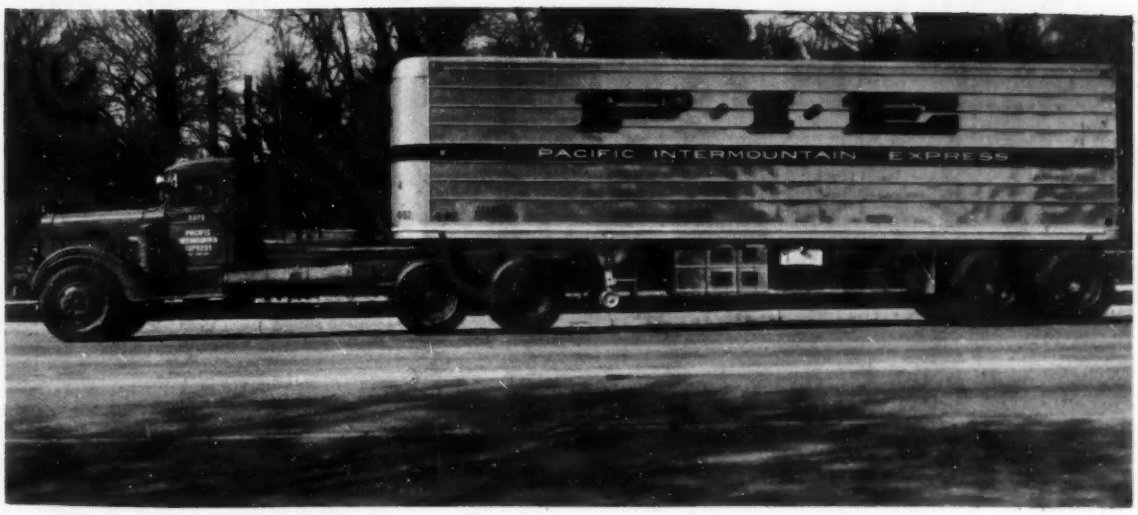
In addition to the smoke and noise problems which are inciting law-enforcing officials to action, weight and length limitations in the 11 Western states narrow the operator's latitude. Table 1 shows how slight variations in legislative codes complicate a carrier's life and limit maximum design development. (Gross weights shown assume 8000 lb on the front axle. Values differ from those in published state codes, but represent what is practically possible with present design under state limitations.)

Take the P.I.E. rig shown in Fig. 1. It travels through California, Arizona, Nevada, Utah, Wyoming, and Colorado. Gross weight limitations in these six states vary from 65,800 to 72,250 lb, while five permit 60 ft overall length and Arizona allows 65 ft. California limits semitrailers to 35 ft; Utah has a 45-ft limit; Nevada has no restrictions. That's why this carrier selects his equipment to satisfy the California code.

These maximum weight restrictions are calculated from formulas based on axle spacing and are limited by arbitrarily-fixed overall lengths. Effect of fixed overall length limitations on formula-calculated loads behooves the manufacturer to eliminate fancy grilles and bumpers projecting well forward of front tires.

Also fancy grille work and passenger car-type front bumpers offer little protection to 70,000 lb in case of collision. They only add to cost of repairs. Vehicles expected to run 500,000 miles soon shake off flimsy chrome trim which weighs something initially and reduces payload. Every pound reduction in tare weight permitting a pound in-

■ Fig. 1 - This large, full-trailer combination, typical of those operated in the West, must comply with weight and length regulations of six states



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crease in payload adds a dollar per year to revenue.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Discuss Manufacturer's Side of Truck Improvement Goal

Discussers at the meeting where Rodgers' paper was presented generally agreed with his exposition of needed improvements in truck design, but pointed out impediments to progress by equipment makers. They say cost, technical limitations, careless operation stand in the way of rapid improvement of grade-ability, transmissions, and the exhaust noise and smoke problems.

According to R. L. Fryer, White Motor Co., an engine of sufficient power to pull the grades at rates specified by Rodgers will be considerably over-powered for flat country needs. That's the case unless train weights in flat country can be built up considerably by special scheduling and suitable legislation.

For power needs to get the performance outlined by Rodgers, Fryer comes up with the following figures:

The installed net horsepower delivered at engine flywheel to drive a 70,000-lb vehicle up a 5% grade at 20 mph is about 260 - assuming optimum gear ratio and good concrete highway. To get the same truck up an 8% grade at 20 mph, it takes about 390 hp. Approximately 175 hp would drive it at 50 mph on level ground, allowing a small reserve for acceleration. With this power the truck could negotiate a 5% grade at about 14 mph and an 8% grade at 9¼ mph.

Perhaps different types of equipment for different kinds of operations could be worked out. Another alternative still to be fully explored, says Fryer, is supercharging.

W. B. Oakley, GMC Detroit Diesel Engine Division, agrees with operators that fatiguing double shifting present a challenge to transmission manufacturers to improve designs. To Fryer the double shift appears unavoidable for conventional shifting-gear transmissions with ten or more ratios. Most efforts are directed toward making the physical job of shifting safer and easier.

To reduce engine exhaust noise and smoke, truck and engine engineers ask for more cooperation from operators. G. F. Roddewig, GMC Truck & Coach Division, cites instances of drivers creating loud exhaust by removing baffles. Most popular way of doing it, he says, is to ram a crow bar through the muffler.

Epidemic of burned-out mufflers during the war he traces to poor quality gasoline. Return of good gasoline during the past year has extended muffler life. Roddewig reports a more or less indefinite life can be built into mufflers - at a considerble increase in cost. The ultimate muffler, he feels, will be a stainless steel unit. But it would cost 30 or 40 times $3.79.

D. J. Cummins, Cummins Engine Co., also asks operators to cooperate in reducing diesel smoke. He says meeting schedules with undersized diesel equipment demands maximum available horsepower and causes excessive smoke. Lack of proper gear ratios, improper maintenance, and use of pirate or "gyp" parts also contribute to the smoke nuisance.

According to Cummins, driver abuse is a realistic problem, not just an alibi for smoking diesels. If the driver punishes his engine in that 70,000-lb vehicle making 18 mph on grade by using the wrong gear or by pulling the engine below its efficient operating range, the engine is bound to smoke abnormally.

Many other smoke-promoting factors, not necessarily controlled by any one group, must be attacked collectively.

TRUCK TIRE Do's and Don't's

BASED ON PAPERS* BY **J. E. Hale**
Chief Engineer,
Firestone Tire & Rubber Co.

TRUCK tires won't hold up if operators abuse them, despite improvements being made by tire engineers. Rapid wear and premature failures will plague any operation if the fleet owner persists in overloading tires, over-or underinflating them, or running them at too-high speeds.

Big nemesis of a tire is heat buildup due to flexing and working of the tire body, particularly when operating outside of recommended load and inflation pressure limits. Since rubber is a poor conductor, heat builds up faster than it's dissipated in the windstream. Heat builds up more in thicker portions - the tread and shoulder areas - where the most action takes place.

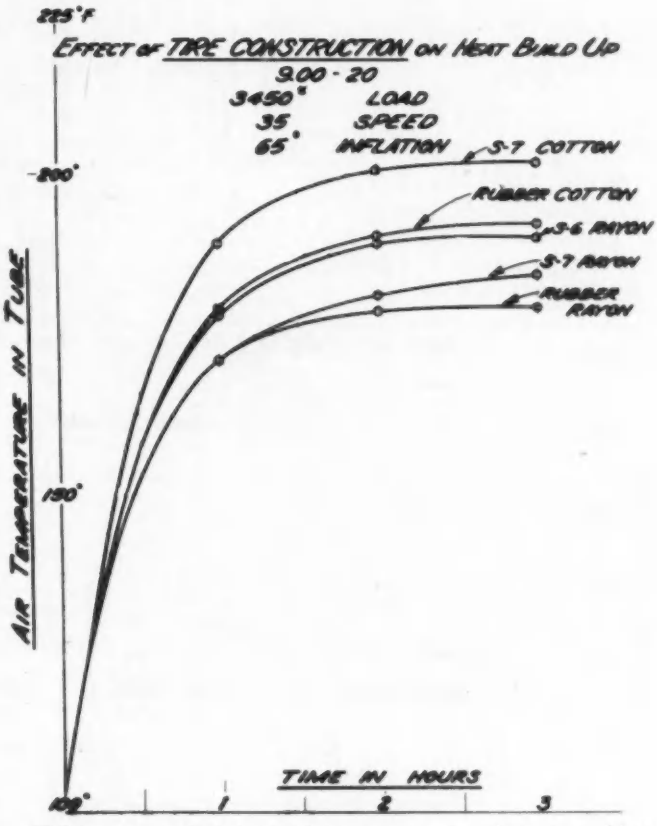
Data on air temperature in the inner tube illustrate the various factors responsible for heat buildup.

First item is the effect of different cord body and rubber constructions. Fig. 1 shows some constructions in tires run much cooler than others under the same operating conditions. Note that in all cases rayon runs cooler than cotton. And the higher the percentage of natural rubber, the cooler the tire.

How does overload influence heat buildup? Fig. 2 shows the temperature rise of a 9.00 x 20 tire run at maximum industry loading, at proper inflation pressure, and at 35 mph. Successive load increases of 1000 lb each produce a marked increase in heat from these overloads. Increase in speed, Fig. 3, and underinflation, Fig. 4, also push up the temperature.

Any of these abuses - overloading, overspeeding, and underinflation - is bad enough alone; but in combined doses they're deadly. Fig. 5 pictures the result of combined overspeeding and overloading. Heat develops to the point of blow-out.

Let's focus on inflation for a moment. Technically there might be some justification for a sliding scale of tire inflation pressures according to the load carried; but it's not commercially feasible. Following simplified recommenda-



■ Fig. 1 - Heat builds up more with a cotton tire construction than with a rayon one

*Paper "Recent Developments in Tires," was presented at SAE New England Section, Boston, March 2, 1948. Paper "Pneumatic Truck Tires," was presented at SAE Virginia Section, Richmond, Nov. 17, 1947.

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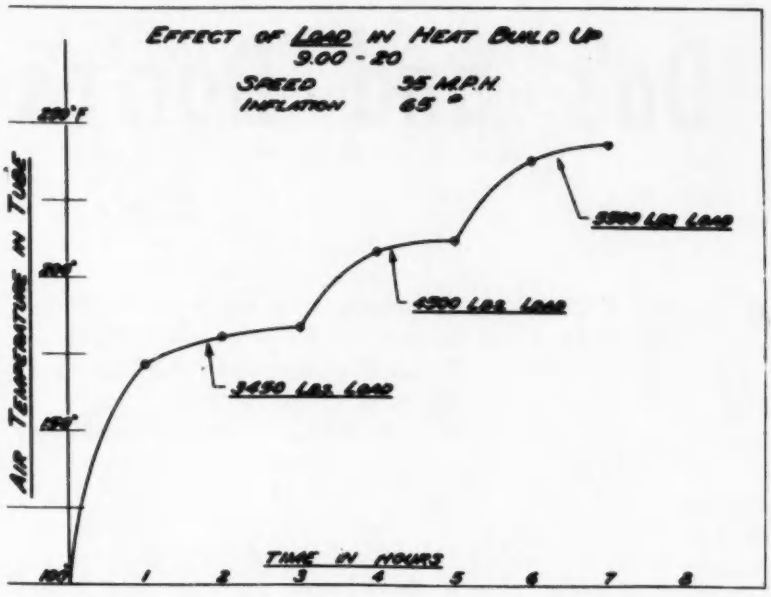
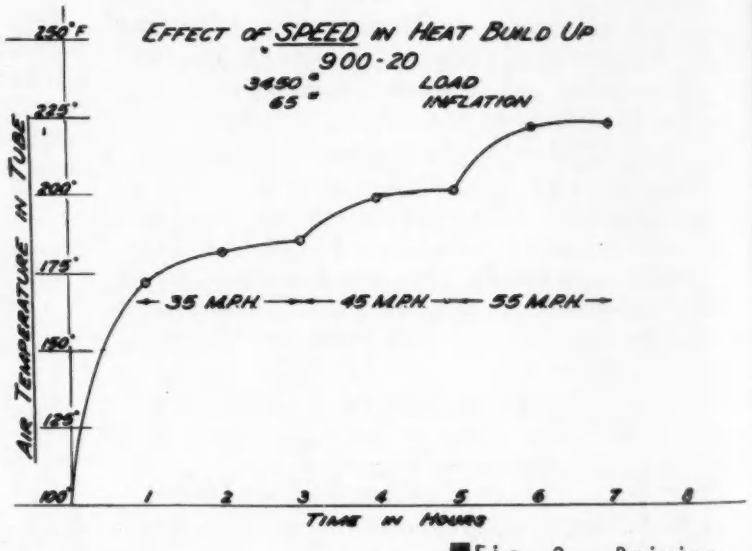


■ Fig. 2 - The greater the load, the greater the heat buildup

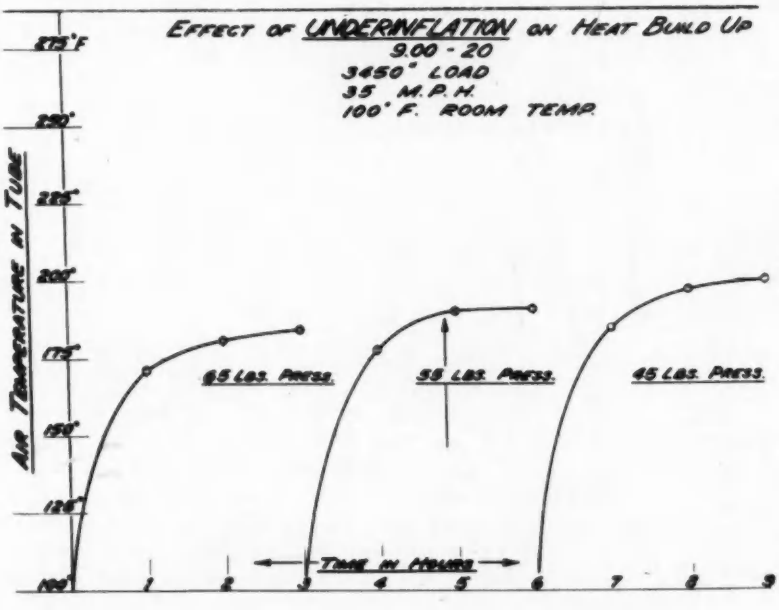
tions, universally used throughout the country, is the best way of doing it, the tire industry found.

In a good many cases truck operators overinflate to compensate for over-loading. While overinflating to match overloading does offset excessive deflections, it does more harm than good. Operators following this practice virtually make a high-pressure tire of a balloon tire without adding the extra plies. The ply-deficient cord body can't take extra stresses imposed on the cord so that



■ Fig. 3 - Driving too fast also promotes tire-destructive heat buildup

■ Fig. 4 - Higher-than-normal temperatures will be found in underinflated truck tires



premature failures from impact breaks are almost a certainty.

Additionally, overinflation concentrates the load in the center of the tread, with high pressure intensity that may lead to early tread separation. Underplied tires, with high pressures producing extra stretch and tire growth, crack excessively in the grooves of the tread

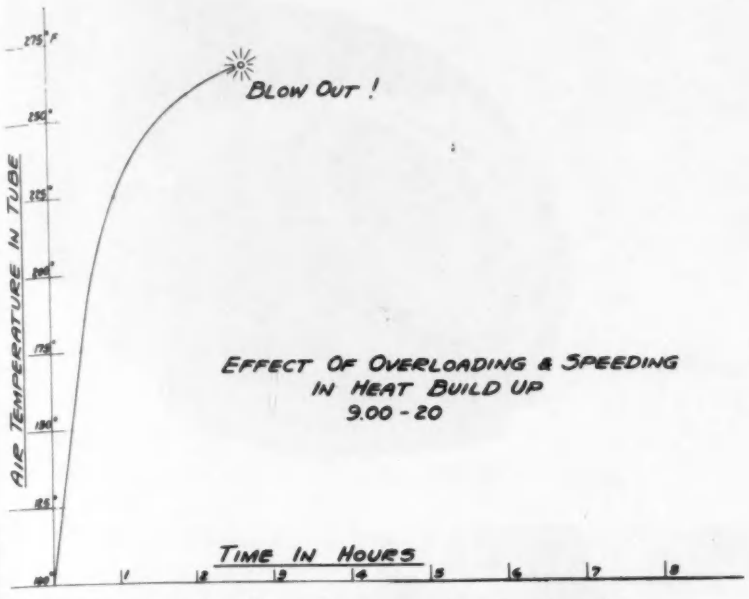


Fig. 5 - Combination of excessive load and speed builds up heat to the point of blowout

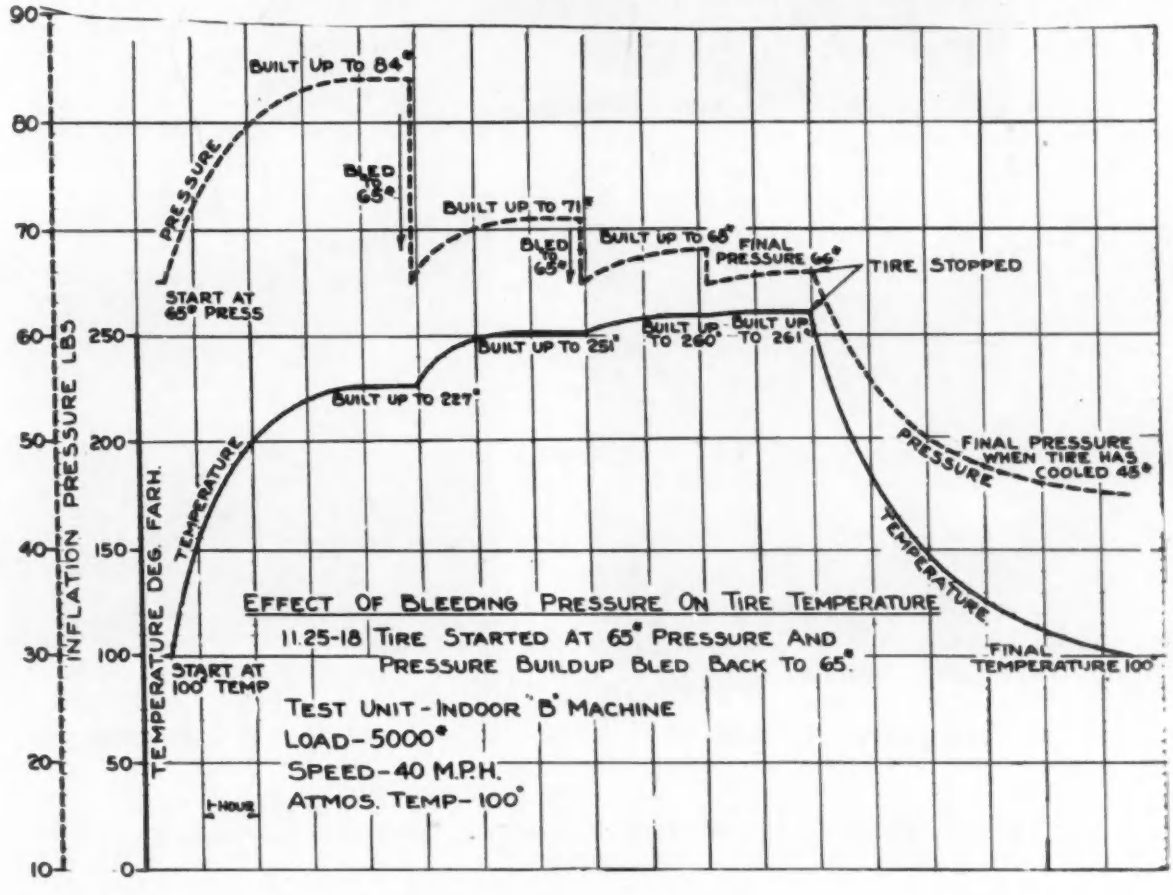
Fig. 6 - These test data add up to one simple operating rule - never bleed pressure while the tire is hot

design.

Another aspect of inflation to be watched in truck tires is bleeding the pressure. Fig. 6, a record of pressure and temperature buildups in laboratory tests, illustrates the point. This recording thermometer chart of an 11.25 x 18 tire, run under standard conditions, shows a maximum temperature rise of 227F with no bleedings. But after four successive bleedings, temperature rose to 261F, which is in the tire danger zone. When allowed to cool, the tire had only 45 psi pressure instead of the original 65 psi.

Operating and maintaining tires properly will get out of tires the life built into them. To understand better the operating and maintenance recommendations listed in this article, let's examine the more prominent types of premature tire failure.

Figs. 7 (a) and (b) illustrate examples of tread and ply separation. There is no way of telling when a tire starts to



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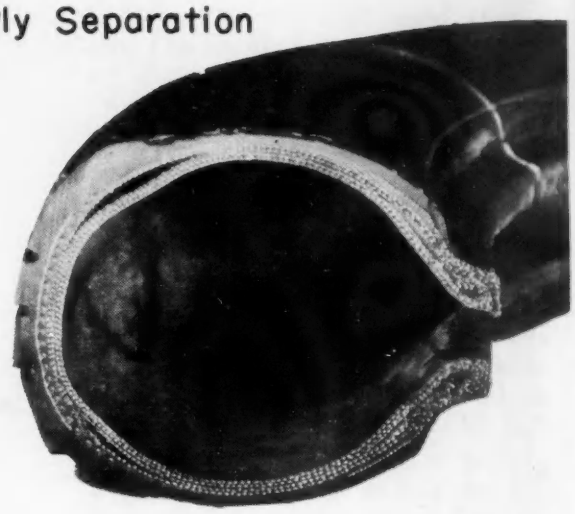
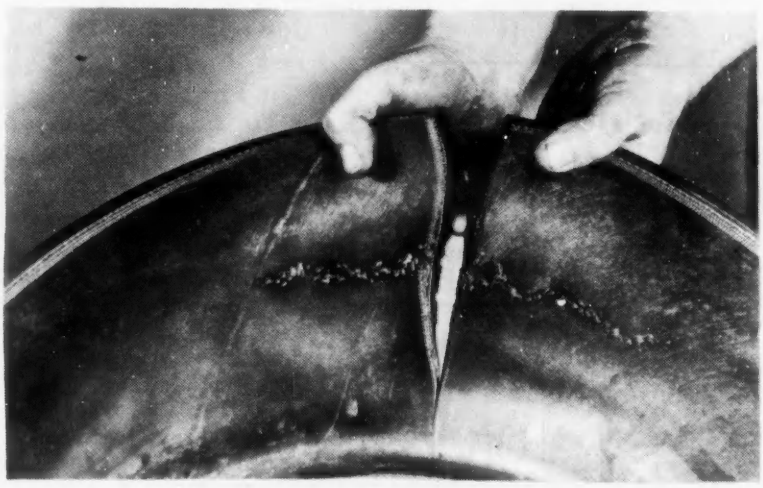
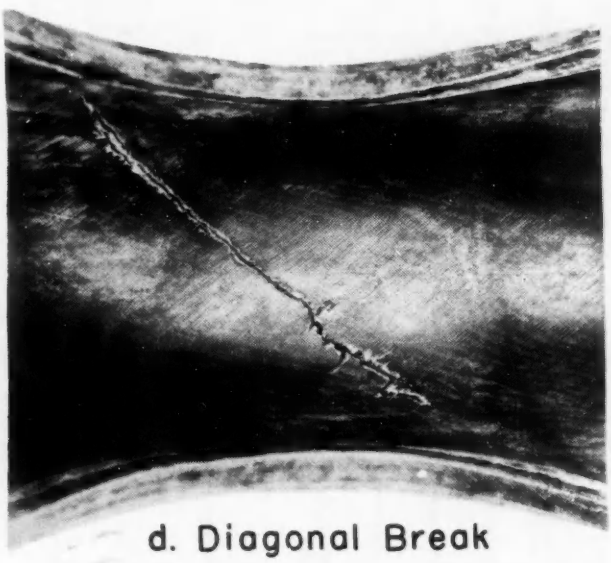
a. Tread Separation

b. Ply Separation

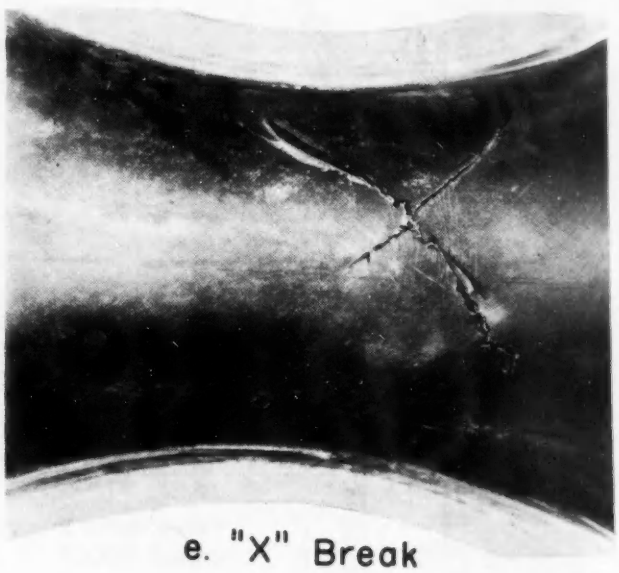




c. Flex Break



d. Diagonal Break



e. "X" Break

■ Fig. 7 - Five types of premature truck-tire failures

Operator's Truck-Tire Check List

- Limit Your Loads. . .
  1. Check load per tire or per axle.
  2. Don't exceed maximum load rating.
  3. Distribute payload evenly on vehicle.
  4. Switch to larger tires for heavier loads.
- Limit Your Speeds. . .
  1. Higher speeds mean higher heat in tires.
  2. High sustained speed is particularly bad.
  3. Recognize seasonal atmospheric temperatures and regulate running speeds about as follows:
     a. Under 40F temperature, cruise under 40 mph average;
     b. 40F to 80F temperature, cruise under 35 mph average;
     c. Over 80F temperature, cruise under 30 mph average.
- Check Your Tire Pressure. . .
  1. Always check tires when cold.
  2. Check tires often enough to make sure you never run underinflated.
  3. Don't overinflate.
  4. Use recommended pressures conscientiously.
  5. Don't bleed hot tire pressures.
  6. Be sure gage is correct - it's important to have a master gage.
- Mate Dual Tires Properly. . .
  1. Maximum difference in diameter inflated should be under 1/4 in.
  2. If diameters differ, keep small tire on inside position.
  3. New tires will "grow" 2 to 3% in first 1000 miles.
- Recondition Tires at Right Time. . .
  1. Have work done by reputable shop - one that uses quality materials, equipment suitable to cure properly, and employs competent workmen.
  2. Watch for cuts and cracks; repair them promptly.
  3. Watch tires as they wear down.
     a. If tread is just worn smooth without cuts or cracks, recap.
     b. If tread is worn almost to cord, full retread.
  4. Check condition of body for cuts and separation before doing any work on.
  5. Be sure tire is dried out before doing any work on it.
- Keep Rims in Good Shape. . .
  1. If rims are undersize, change to proper size.
  2. Clean corrosive pitting from rim flange and base.
  3. Paint if in bad condition.
  4. Replace or straighten bent flanges.
  5. Check against using wrong size side rings - it frequently happens in mixups.

separate until it is too far gone. Once it starts, chafing in the separated areas develops rapidly and spreads until the tire is ruined and there is no way of repairing it.

First example of premature cord body failures, shown in Fig. 7 (c) is the flex break. It's a circumferential failure in the mid sidewall region, half way up between the tire bead and shoulder, caused by excessive flexing.

First, one or two cords let go; neighboring cords have to carry the load and then they break. The succession of breaks continues until quite an extensive circumferential section ruptures completely, the tube chafes through, and you get a flat. None of this action can be seen from the outside.

When the tire overheats, a diagonal break develops in the crown. as in Fig. 7 (d). High temperature weakens the cord. Operating stresses combined with internal air pressure are just too great - and the cord body bursts. This isn't a gradual development, it's an instantaneous affair known as blowout.

A less frequent but equally annoying blowout is the "X" break, Fig. 7 (e),

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also in the tire crown. In this case some pointed object crushes into an overheated tire and makes this kind of instantaneous break. Result: a blowout.

Although truck tires today withstand about 25 million flexings in a normal 50,000-mile life, tire engineers still are at work making them better. Stronger cord body construction and wide-base rims are just a few of such improvements.

The tire industry seeks stronger cords for a given gage and also a cord construction that won't elongate appreciably and will withstand repeated flexings. Rayon has rendered yeoman service and is, of course, a basic cord structure of truck tires. Nylon offers interesting possibilities, but has two limitations.

NYLON DRAWBACKS

First, it stretches. This very property, that makes it so desirable for ladies hosiery, the tire engineer cannot accept. For example, tires of ordinary cotton or rayon grow or stretch about 3% after running 1000 miles; a nylon-cord stretches two or three times as much. This stretch localizes in grooves of the tread and produces cracks there. Work is now under way to reduce elongation characteristics of nylon. Second limitation, price, handicaps use of nylon because it's two or three times as much as rayon.

The cord situation lines up this way: gage for gage rayon is about twice as strong as cotton and nylon is about twice as strong as rayon. Cutting down the number of cords and gage per inch will reduce bulk, quantity of materials, and eventually price. Additionally, less bulk means thinner tires that will run cooler and eliminate detrimental heat buildup.

Something new has happened in rims. The so-called Advanced Rim program since the war offers these four fundamental improvements:

1. Tighter bead fit;
2. Rim width increased to about 70% of tire section;
3. Wider range of rim cross-sections, one for each tire size;
4. Improved rim flange contour to support the tire bead better laterally.

Chief feature of the program - tight bead fit - stems from a 5-deg taper on the rim bead seat that laterally forces the tire bead onto the seat with a tight fit. It stabilizes the bead, prevents it from rocking and chafing its outside surfaces into premature failure.

The increased width - providing a 70% ratio of rim width to tire section - increases tire durability, makes it stabler, and extends tire-body life.

Third wide-rim program improvement, a rim profile for each tire section, enables the manufacturer to do a better job of engineering rims for tires. The improved rim contour also is a step forward. Flanges of old-style rims had very limited vertical surfaces, with a large flaring curve designed into the flange. The new rim has a substantially-increased vertical surface so that it supports the tire bead laterally.

(Paper "Pneumatic Truck Tires - 1948," is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Better Engine Design

CONTINUED FROM PAGE 42

served; sludge which formed at high operating temperatures was due to oxidation of the oil. When this was ascertained, oxidation inhibitors were added to the oil, and oil oxidation decreased to insignificance. Later, heavy-duty oils, which contain not only oxidation inhibitors but also detergent and corrosion-protection additives, were put on the market. But, heavy-duty oils were specifically designed not to be affected by water, and they will not prevent deterioration of oil due to the presence of water, Nor will heavy-duty oils counteract abnormal dilution of oil with fuel, because gasoline is oil-soluble. The detergent additives can give some relief from low-temperature sludge, but the real cure lies in modifying the engine design.

(Complete papers on which this article is based are available from SAE Special Publications Department. Price: 25¢ each to members, 50¢ each to nonmembers.)

Improved DESIGN and OPERATION Emphasized

SUGGESTIONS for bettering trucks and buses, news of projected equipment improvements, and facts about special maintenance needs emerged from the SAE national Transportation Meeting at the Bellevue-Stratford Hotel in Philadelphia, March 30 to April 1. Behind these highlights were papers and discussions giving clear-cut descriptions of currently used types of automotive electrical equipment, fuel injection systems, and cooling systems - along with detailed description of how one large truck operator does his own apprentice mechanic training.

Discussions disclosed that economics of fleet operation still holds top priority in operators' thinking.

More than 300 members and guests attended the sessions, and 260 heard Henry G. Weaver, General Motors Corp., at the dinner on Wednesday evening, tell his dynamic story of how not to prevent human progress. SAE President R. J. S. Pigott spoke briefly at the dinner, emphasizing the need for improving existing methods of producing motor fuel synthetically and from shale. Toastmaster was J. Wallace Fager.

Our country is far from perfect, Weaver said, but when we imagine that a short-cut to the millenium lies in substituting government control in the place of self-reliance and individual responsibility, we are falling for the ancient delusion which, for over 6000 years, has stagnated human progress - and kept most people in the world underfed, underclothed, and surrounded by famine. . . We in the United States have made more effective use of our energies than any other people - because each of us has had freedom of opportunity to apply his energy, imagination, and inventive ability to creation of new things, with the chance of sharing the fruits of his extra effort.

Gavin W. Laurie, chairman of the General Committee for the meeting, left, with Henry G. Weaver, General Motors Corp., the banquet speaker, and Toastmaster J. Wallace Fager

DESIGN IMPROVEMENTS SUGGESTED

Suggestions for improving design were varied but specific. More extensive use of weight-saving materials was urged in trucks for operations where the higher initial costs can be more than offset by resulting operating economies. Suggested also were higher coolant temperatures for

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ordinary car and truck engines - and development of spark-ignition engine designs to utilize the full benefits of modern, lower-cost injection pumps and nozzles.

Possibilities of weight-reducing were estimated by various operators as being worth from $1 to $4.50 of initial cost per lb of weight saved, depending on the conditions of vehicle use. A figure of 1¢ times a day's mileage was quoted as weight-saving value in one case. Evidence accumulated throughout the meeting, in fact, that, for certain over-the-road operations, reducing vehicle weight pays substantial dividends. It seemed equally clear, as stressed by manufacturer representatives, that really extensive weight reduction would not pay in a majority of operations.

LIGHT METALS NEED REDESIGN

One operation where increasing use of weight saving materials since the late '20's has paid off was the basis for more than a few design suggestions. Standard iron or steel design, machining or assembly practices are unwise, this experience indicates, in applying the lighter weight materials. Long radii, sweeping curves, thick sections, avoidance of stress concentrations, shrink fits and protection from abrasion are musts. Sharp fillets, notches, or rough handling must be avoided. Use of insulating materials between dissimilar metals to prevent electrolytic action is imperative. . . Incentive to reduce tare weight, and thereby increase net load and gross revenue, it was stressed, increases as cost of materials and labor keeps rising.

Higher coolant temperatures for cars and trucks were suggested as an improvement following an analysis of modern developments, including those in the aircraft field, which indicate such higher temperatures feasible. Allison and Rolls-Royce aircraft engines, it was stated, operate at 260F jacket temperatures under 25 psi with a 70-30 glycol-water solution which has a boiling point of 302F. Despite differences in air and ground requirements, it was stressed, principles do not change and we may learn from studying them regardless of the application.

There is no reason why ordinary engines can't be operated at higher temperatures, one expert said - and met with anticipatory fears in most of those commenting further on the subject.

Despite advantages cited for it - such as smaller radiator, lighter engine, no low-temperature sludge, no thermostats, no water pumps, and closer tolerances - several engineers saw higher cooling temperatures introducing new troubles.

Engine men weren't worried about the engine, since higher temperatures and pressures little affect design stresses.

But, they asked, won't cooling system leaks be more troublesome and harder to repair?

What happens if the pressure system gets clogged?

Will the more expensive cooler design offset savings from reduction in fan and cooler size?

Will the safety margin for high summer temperatures complicate temperature and pressure regulation for various conditions?

Operators saw the proposal as a mixed blessing. Higher temperature cooling to some spelled boost in octane requirement and potentially greater breakdown of lubricating oil.

Another, noting that aircraft engineers realized an 8 to 11% efficiency gain by raising coolant temperature 150F, felt any increased maintenance would nullify the fuel economy advantage.

Although enthusiastic about its possibilities, one truck builder said high temperature cooling adds little to thermal efficiency. . . about 6%. If hot cylinders give better efficiency, then the sleeve valve engine should be more efficient than overhead-valve and L-head engines, he rationalized, since its heat transfer at this point is relatively poor. But the facts don't support the theory.

FIRE DETECTORS

Increased use of fire-detecting devices was suggested as an improvement for both bus and truck design. They should be installed at advantageous locations, several engineers urged, such as at carburetor, fuel pump, propeller shaft, brake, auxiliary heater, and fuel tank. These de-

■Dale Roeder, SAE Truck & Bus vice-president, left, with SAE President R.J.S. Pigott, and Warren A. Taussig, SAE T&M vice-president

■B. Frank Jones, Philadelphia Section vice-chairman for Truck & Bus, left, with Philadelphia Section Chairman E.R. Kinnebrew, and Linn Edsall, the Section's vice-chairman for Transportation & Maintenance

vices, it was pointed out, permit the operator to extinguish a fire before it gets beyond control - increasing the safety of both passengers and commodities.

Suggested specifically for buses was a fire-proof barrier between possible fires and the passenger compartment consisting of a duct or firewall made of two metal pieces with fire resistant insulator sandwiched between the form and base, while the normal floor is the top section of the duct. This would not only provide a 2-in. air gap between firewall and wood floor, but also serve as a warm air passage to the driver and passenger compartment. Urged also was use of noncombustible materials in every possible element of construction - and foregoing of all actually flammable materials.

In electrical equipment design, it was urged that engine requirements be established at low temperatures; that temperature, starting motor design, and battery capacity be selected as a team. Result will be reduced weight and space . . . Designers also were asked to figure an overall factor of safety for the whole starting system - not just for each individual part.

Other electrical system design sug-

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gestions included one that alternators with rectifiers offer more possibilities for operation over greater speed ranges than interpole or shunt d-c generators; another that greater dependability and interchangeability be established; and a third that design produce systems capable of working better under both low and high temperature operation.

Suggestions that more attention be paid to fuel injection for spark-ignition engines were based on recent and projected improvements in reliability and reduction in cost, as well as on the need for further research toward even better units. Remaining research problems, it was said, include more study of unthrottled intake air with fuel charge stratification, direct cylinder injection, intake and exhaust manifold designs; better cylinder scavenging, dual-fuel engines, and two-cycle, aircooled and high-output engines.

Realistic appraisal of these yet unsolved injection problems came from researchers and practical vehicle men alike. Good things voiced for fuel injection were met with notes of pessimism from "doubting Thomases," who want to see results before accepting theory-promised cure-alls.

SIMPLE LINKAGE WON'T SUFFICE

Satisfactory air-fuel ratio - one yet unrealized injection need - won't come from a simple linkage between air and fuel throttles, said a fuel injection specialist. He sees several possible answers, along the lines of aircraft controls, though less complicated and cheaper because of fewer variables involved.

But a vehicle engineer advanced the thought that air distribution can be adversely affected by differences between different cylinders, or even between different cycles in the same cylinder. Claimed advantage of improved scavenging, through increased overlap, he said, seems more theoretical than actual. The average commercial truck engine already operates at about maximum overlap possible while maintaining satisfactory idle.

Another investigator in the field sees direct injection bringing down octane requirement by reducing "residence time" of fuel in the combustion chamber. He feels late injection during the injection stroke is the way to do it.

Price for decreased octane requirement with timed injection was said to be comparatively expensive fuel pump and substantial loss in maximum power output.

Despite differences in degree of enthusiasm for fuel injection, most agreed the goal worthy of continued development - especially in the light of such potential features as improved starting ability in cold weather and wider latitude in fuel volatility.

NEW PRODUCTS AHEAD

Revealed during the meeting was news of projected improvements in electrical equipment, fuel injection systems for spark-ignition engines, and protection of buses against fire hazards.

Coming electrical system developments mentioned included an overrunning clutch in the starting line for use on the larger 12 and 24-v starting motors; a starting motor operated by compressed air for cranking diesel engines; higher output a-c alternator-type generators; a modified aircraft-type generator for use with a carbon pile regulator; and, for the more distant future, electronic ignition systems which engines of the near future will not require.

In the fuel injection area, simplified injection pump designs, probably of the single-plunger type, it was predicted, will be "universally available" - and demands for low-cost equipment will be met. Also mentioned was a simplified pintle nozzle and holder, which opens outwardly and does not require drain lines - also at lower cost.

Fuel tanks of even greater collision resistance were prophesied for buses as the result of studies which already have placed scores of features in bus design to meet high requirements in reducing and resisting fire hazard. In addition, fire detection devices around the engine, brake drums, and other high-heat areas (as suggested by discussers) may be added to the many precautions already in use.

Whatever the equipment or whatever the vehicle, proper operation and maintenance is needed in addition to sound original design. This thought cropped up in many discussions throughout the meeting.

It was emphasized strongly by postwar decision of some operators to train their own apprentice mechanics, when needs became greater than could be met by trade school sources. It was noted as a factor in successful use of weight-saving materials in trucks, and in keeping fire hazards to a minimum in bus operation and in talking of electrical equipment. In arguing the possibility of higher coolant temperatures, too, service angles played a part in the debate - as they did also in discussions evaluating the advantages and disadvantages of fuel injection for spark-ignition powerplants.

LIGHT WEIGHT AND MAINTENANCE

Some special service difficulties were admitted by proponents of weight-reducing materials for trucks. Washers, wear plates and other parts to protect the softer metals, for instance, must always be tight and kept tight. Welding heat-treated materials, whether steel or aluminum, has to be avoided in maintenance because necessary annealing usually is impossible.

But some service advantages accrue, it was claimed. Push-pull cables (held by an aluminum bracket) with which the transmission is shifted have reduced weight and reduced the amount of regular repair. "Competent men can be readily trained to properly maintain parts made from weight reducing materials," it was stated categorically by an experienced operator, who added: "It is not unreasonable to expect life in excess of a million miles without excessive maintenance from vehicles using such materials for a substantial percentage of their tare weight."

Role of maintenance in decreasing bus fire hazards, it was brought out, centers around keeping brakes properly adjusted so they won't drag and generate excess heat, periodic steam cleaning of the engine area to keep oily film at a minimum, and careful checks for soft tires, misaligned wheels and other factors. In the case of tires, it was pointed out, driver habits and care can do more than maintenance to prevent overheating.

Combination service-operating problem mentioned on electrical systems was that of continuous cranking to start. It was agreed that starting motors can't be cranked continuously until battery is discharged, because they will fail from overheating. Suggested was a cranking cycle of 30 sec crank and minimum of 2 min rest, before second attempt. If engine fails to start during first cycle, it was said, the operator ought to look for the trouble. It was also suggested that voltage regulator contacts can be cleaned properly if the job is done before coatings are penetrated, thus saving contact replacement.

Higher maintenance costs was one of the four reasons given at the meeting for currently limited use of fuel injection systems, while increased service problems arising from steam pockets, seals, gaskets and lubrication were argued as reasons for current 140-180F jacket water temperatures as against the higher temperatures suggested as an improvement.

1948 SUMMER Meeting Program

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French Lick Springs Hotel
French Lick, Indiana

SAE SUMMER M

SUNDAY, JUNE 6

7:00 p.m. GET-TOGETHER BANQUET
Main Dining Room

8:30 p.m. PROGRAM
Convention Hall

A.W. Herrington, Chairman

"Thoroughbred Men and Machines"

WILBUR SHAW
President, Indianapolis Motor Speedway Corporation

"Crucible of Speed"
Special Feature Film

MONDAY, JUNE 7

9:30 a.m.

The Automotive Industry's Participation in Reduction of Radio and Television Interference.
-P.J. Kent, Chrysler Corp.

The Highway Traveler - Greyhound's New Intercity Bus
M. M. Dean, Greyhound Corp.

(Sponsored by Transportation and Maintenance Activity)

1:30 p.m.

Application of Nondestructive Testing to Automotive Parts
-D. M. McCutcheon, Ford Motor Co.

The Automotive Designer's Concept of Steel vs. Light Metal
-D. F. Toot, Chrysler Corp.

(Sponsored by Engineering Materials Activity)

3:45 p.m.

Factors Affecting Design Installation of Wiring Systems for Commercial Vehicles
-L. C. Wolcott, Packard Electric Division, General Motors Corp.

(Sponsored by Transportation and Maintenance Activity)

8:30 p.m.

Character in the Styling of Automobiles
-Wilder Hobson, Fortune

Prepared Discussion by Maurice Olley, Vauxhall Motors, Inc.; R. H. Dietrich, Styling Consultant.

(Sponsored by Body Activity)

TUESDAY, JUNE 8

9:30 a.m.

Future Commercial Highway Transportation
-J. S. Worley, University of Michigan

Prepared Discussion

(Sponsored by Truck and Bus Activity)

1:30 p.m.

Hudson's New Look
-F. S. Spring, Hudson Motor Car Co.

(Sponsored by Body Activity)

3:45 p.m.

Principles and Applications of Isothermal Heat Treatments
-J.M. Hodge, Carnegie-Illinois Steel Corp.

Section Size - Hardness - Composition Relationship in Cast Iron
-R. G. McElwee, Vanadium Corp. of America

(Sponsored by Engineering Materials Activity)

8:30 p.m.

Revolutionary Development in Wheeled Military Vehicles
-Colonel J. M. Colby, Ordnance Department

(Sponsored by Truck and Bus Activity)

WEDNESDAY, JUNE 9

9:30 a.m.

SYMPOSIUM ON NEW ENGINE DESIGN

The New Packard Straight Eight Engines
-G. A. Sprague, Packard Motor Car Co.

The Willys-Overland 148 Cubic-Inch Six-Cylinder Engine
-Paul Huber, Willys-Overland Motors, Inc.

Features of Nash Engines
- E. L. Monson, Nash Motors Division, Nash-Kelvinator Corp.

(Sponsored by Passenger Car Activity)

■

2:30 p.m. FIELD DAY

MEETING

JUNE 6-11, 1948

8:30 p.m.

50 Years of Diesel Engine Development in the U.S.A.
- Rex W. Wadman, Editor and Publisher, Diesel Progress

(Sponsored by Diesel Engine Activity)

THURSDAY, JUNE 10

9:30 a.m.

Steering and Geometry Characteristics and Their Influence on Car Handling
- H. E. Churchill and P. G. Hykes, Studebaker Corp.

A Modern Approach to Ignition
-L. H. Middleton and Chester Cipriani, Electric Auto-Lite Co.

(Sponsored by Passenger Car Activity)

1:30 p.m.

SYMPOSIUM ON COLD WEATHER OPERATION

Engineering Developments Required for Satisfactory Low Temperature Aircraft Engine Operation
-William Weitzen, Chief Extreme Weather Unit, Wright Field

Auxiliary Equipment Required for Low Temperature Aircraft Engine Starting
-Lt. J. R. Roche, Equipment Laboratory, Wright Field

Movie on Cold Weather Testing
CLOSED SESSION - This session, contributed by the U.S. Air Forces, will be limited to SAE members who are U.S. citizens.

(Sponsored by Aircraft Powerplant Activity)

3:45 p.m.

Super-Power for Super-Railroads
-J. W. Barriger, Chicago, Indianapolis and Louisville Railway Co.

The Production and Performance of Diesel Fuels
-J.R.MacGregor, G.R.MacPherson and P.L. Pinotti, California Research Corp.

(Sponsored by Diesel Engine Activity)

8:30 p.m.

Air Transport Problems
- Vice-Admiral E. S. Land, (Ret.) President, Air Transport Association of America

(Sponsored by Air Transport Activity)

FRIDAY, JUNE 11

9:30 a.m.

SYMPOSIUM ON SUPPLEMENTAL ANTI-KNOCK QUALITY FOR GASOLINE

Anti-Detonant Injection
-C. H. Van Hartesveldt, Thompson Vita-Meter Corp., Wholly-Owned Subsidiary of Thompson Products, Inc.

Use of Anti-Detonant Injection in a High-Compression Ratio Engine
-R. I. Potter, Standard Oil Co. of Ohio

Progress Report on the Dual-Fuel System
-W. M. Holaday, Socony-Vacuum Oil Co.

(Sponsored by Fuels and Lubricants Activity)

1:30 p.m.

The Cycle Analysis of Gas Turbine Propeller Engines with Turbine Blade Cooling
-R. O. Bullock and R. E. English, National Advisory Committee for Aeronautics

Potential Performance of the Turbojet Engine at Subsonic and Supersonic Speeds
-R. V. Hensley, N. D. Sanders and R. P. Krebs, National Advisory Committee for Aeronautics

(Sponsored by Aircraft Powerplant Activity)

3:45 p.m.

A New Approach to the Evaluation of Fuel Volatility and Associated Engine Variables
-H. J. Gibson, Ethyl Corp., and J. E. Taylor, Gulf Research and Development Corp.

Taking Guesswork out of Crankcase Ventilation
-B. G. Brown, Ford Motor Co.

(Sponsored by Fuels and Lubricants Activity)

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Combustion Just Part Of Fuel-Engine Woes

Based on paper

By T. B. RENDEL

Shell Oil Co., Inc.

FINDING the correct fuel to satiate the internal combustion engine's appetite is complicated by other-than-combustion requirements. Petroleum technicians and engine designers must cope with such fuel handling and rating for gas turbines as well as for more familiar spark and compression-ignition engines.

Gas turbine specialists want a fuel that flows at lowest conceivable starting and flying temperatures. While present fuels do the job on freezing point and viscosity at various temperatures, they're too restrictive.

Fuels may have as much as 0.015% water dissolved in them which can ice and clog the filter. Lowering the temperature reduces the fuel's water tolerance so that water eventually precipitates out and forms ice crystals - well above the fuel's cloud point.

Another turbine-fuel problem is the safety angle. Although kerosene or low-volatility naphtha are far less inflammable than gasoline, as measured by rate of flame propogation, explosion limit for kerosene may be in a much more dangerous temperature and altitude range. For normal altitudes and temperatures, fuel tanks are much more explosive with kerosene than with gasoline.

There isn't any "safe" fuel. Just as many precautions must be taken with jet fuels as with aviation gasoline.

CAR ENGINE PROBLEMS

In the automotive engine field, changing car design points up a need for critical review of the two current antiknock rating methods. The Uniontown method is based on relative knock intensities at different car speeds; the Borderline method relates to permissable spark advance at different speeds. Uniontown fuel ratings check fairly well with similar evaluations made by customers. Petroleum refiners and engine builders use the Borderline method in research.

What's sorely needed is a sound technique for evaluating detonation characteristics of the fuel-car combination that meets with general agreement as to scope and usefulness. This isn't the case with the present two methods.

As for diesels - compression-ignition engines - the two big problems are mixing and impurities. Fuel and air must be mixed while burning so that combustion is completed in an orderly manner and in the shortest possible time. Perfect mixing would insure clean combustion. But ample turbulence, easiest way of getting perfect mixing, expends some energy and losses heat and efficiency unless the combustion chamber is carefully designed.

Chief impurity is sulfur. Cooperative research on this problem promises to yield an early solution.

(Paper "Fuels of the Future," was presented at SAE St. Louis Section, Oct. 14, 1947. This paper is available in full mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

API Work Relates Knock To Molecular Structure

Digest of Paper by

WHEELER G. LOVELL

Ethyl Corp.

(This paper will be published in full in SAE Quarterly Transactions.)

API Research Project 45 has piled up the largest existing body of knock data on hydrocarbons through nine years of testing on 225 pure hydrocarbons, some at as many as 29 sets of operating conditions.

Testing techniques have been developed to a point where it is possible to get a good general picture of the behavior of a particular compound with only a few engine tests and about a pint of the fuel. On the basis of all the data collected, a number of generalizations can be made about the relation of knock to molecular structure, the relative sensitivities of different fuels, and the effectiveness of tetraethyl lead.

For example, a chart has been prepared for paraffin hydrocarbons which shows critical compression ratio as a function of the number and arrangement of carbon atoms in a molecule. On the compression ratio scale, some compounds are as much better than iso-octane - which rates as 100 octane - as iso-octane is better than n-heptane - which rates zero on the octane scale. The chart shows how good the best compounds can be; it appears that with the best compounds, such as triptane, spark-ignition engines can be operated up to diesel compression ratios without knock and at comparable efficiencies.

The chart also shows that the arrangement of the atoms in the molecule makes a big difference in its knock tendencies. Although all the octanes are C_8H_{18} and most have similar physical properties, there are 18 possible molecular arrangements—some which knock at compression ratios of 2:1 and others which can stand up to 15:1.

Charts have been prepared for cyclopentanes, cyclohexanes, aromatics, and straight chain olefins, as well as for paraffins.

Generalizations on the sensitivity of various hydrocarbons lead to the conclusion that engines designed to use superfuels must be rather mild. As a class, paraffins are least sensitive, but some paraffins of high antiknock value knock at lower and lower compression ratios as engine temperatures are increased. Under very severe conditions, no fuel component yet found is superior to iso-octane. In the classes of hydrocarbons other than paraffins, some compounds are very sensitive and some are not. This means that a wide variety of commercial fuels can be made from all classes.

In general, the effect of the addition of tetraethyl lead to paraffin fuel hydrocarbons is to increase the anti-knock level. Exceptions to this rule are certain highly branched paraffins of about 100 octane number in which lead is almost without effect in a supercharged engine. Lead is most effective in paraffins and naphthenes. In other classes its effect varies widely. (Paper "Engine Knock and Molecular Structure of Hydrocarbons," was presented at SAE Annual Meeting, Detroit, Jan. 16, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Longer-Life Paints Coat Today's Cars

Based on paper
By M. G. BELL
and W. W. BAUER
Paint Division,
Pittsburgh Plate Glass Co.

TESTS during the last dozen years show automotive lacquers and synthetic enamels have become increasingly more color-fade resistant and more durable.

Ten years ago certain colors in lacquer - particularly pastels - faded noticeably. This restricted their use in regular production and limited the range of practical colors. Introduction of new pigment compositions, - in greens, blues, and maroons - had a marked affect on color permanence and made practical many beautiful pastels. See Fig. 1 (a).

RETAIN COLOR

Just as with lacquers, colors previously fugitive in synthetic finishes now hold up well. Fig. 1 (b) charts this improvement and shows that delicate pastel shades now remain practically unchanged for life of the finish.

Better binders and pigments in lacquers have reduced chalking. - an erosion of the top surface of the paint film through weathering. See Fig. 2 (a). Especially is this true for the 1936-to-1941 period. Vehicle improvement also contributed to better chalking resistance.

Fig. 2 (b) demonstrates the same trend with synthetic enamels. Here gloss retention is integral with chalk rate because loss of gloss is a function of the pigment. Biggest factor responsible for improving chalk resistance of synthetics is the bettering of titanium dioxide quality in the last ten years.

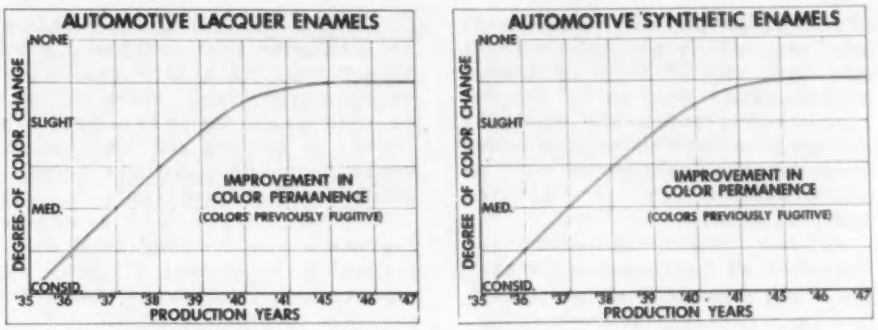
CHALKING RETARDED

In 1936 chalk rate was practically a straight-line function. Chalk retardation then was a job of modifying white pigments. Certain colors were not used to avoid excessive chalking. Constant improvement in titanium pigments has delayed considerably initial appearance of chalk. Fig. 2 (b) shows four months of exposure in Florida in 1936 produced a heavy chalk accumulation; in 1947 chalking barely started after four months.

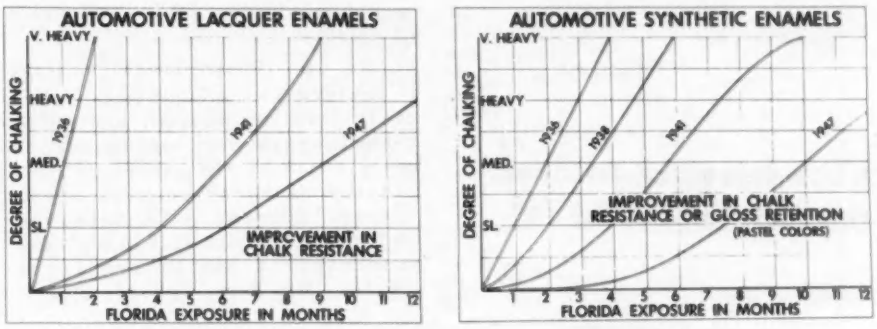
Two things uppermost in the car owner's mind are (1) how long will the paint job look new and (2) when will it need refinishing. Comparative life span of lacquer finishes from new condition to need for repainting are plotted in Fig. 3 (a). Though time to repaint is a matter of personal judgment these curves are progressively comparative and depict conservative serviceability estimates.

Increased durability during the last decade applies as well to synthetics, as shown in Fig. 3 (b). General condition of synthetic enamels now is as good after 2 1/2 years as it was after six months, 10 or 11 years ago. Comparison of Figs. 3 (a) and 3 (b) shows both types of finishes - lacquers and synthetics - are about equal in service characteristics.

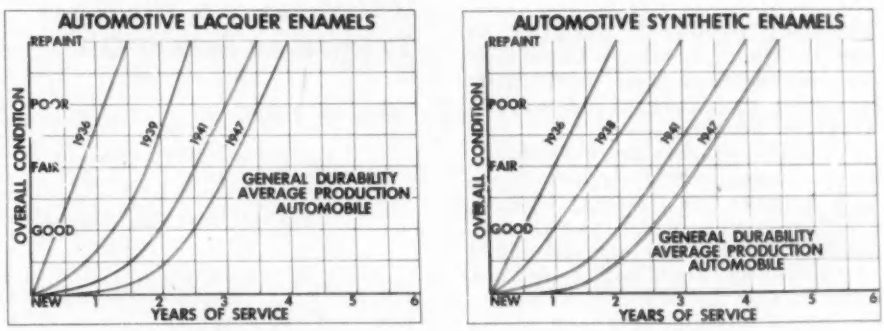
Other paint properties such as luster retention and workability have shown similar gains over the past 10 to 12 years.



(a) Fig. 1 (b)



(a) Fig. 2 (b)



(a) Fig. 3 (b)

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It's up to the car manufacturer who uses paint products to get the best out of them by proper application. This calls for cooperation between the supplier and user industries to understand each other's problems as well as the product – its possibilities and limitations.

(Paper "Improved Automotive Finishes as Engineering Materials," was presented at SAE Annual Meeting, Detroit, Jan. 13, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

NACA Research Focused On Eight-Point Program

Based on paper

By HUGH L. DRYDEN

National Advisory Committee for Aeronautics

CURRENT research program of the National Advisory Committee for Aeronautics aims at finding answers to these eight civil-aviation problems:

1. Aerodynamic Performance – Drag reduction and high-lift devices for lowering landing speed are the main problems. Fundamental studies are under way on laminar-to-turbulent transition of air flow, and control of boundary layer flow by airfoil shape and by suction.

2. Flying Qualities – NACA researchers are studying stability and control, stalling characteristics, and factors affecting spinning. Recently work was completed on optimum flying qualities for blind flying.

3. Vibration and Flutter – Projects are being established on flutter elimination, minimizing vibration and its transmission from source to other airplane parts, and assurance of structural integrity under all flight conditions.

4. Air-Frame Materials and Structures – Much systematic basic research is in progress on types of structures in modern aircraft. Of current interest is a study of life of actual aircraft structures under repeated loading.

5. Propulsion – Research in this area includes basic work on new materials more resistant to corrosion, wear, heavy stresses, and high temperatures; on fuels; on cooling and cowling; on combustion; on complete powerplants; and on propellers.

6. Aircraft Loads – Engineers are finding load distribution in normal flight, in maneuvering, in flight in turbulent air, and on landing impact.

7. Rotary Wing Aircraft – Current projects include basic studies of air flow through rotors, tests of blade sections for rotors, performance, stability and control, air loads, and blade stresses.

8. Operational Problems – Ice-prevention systems, aircraft fire prevention, and noise reduction in personal aircraft cover a few of the phases of continuous research in this area. (Paper "Current NACA Research on Civil Aviation Problems," was presented at SAE Metropolitan Section, New York, Feb. 18, 1948.)

U.S., Venezuela, Mid-East To Produce Bulk of Oil

Based on paper

by C. O. WILLSON

"The Oil and Gas Journal"

THE bulk of world oil supplies over the next several years will come from three areas: the United States, Venezuela, and the Middle East. Neither newly discovered oil fields nor rehabilitated prewar sources will challenge production figures for the three big producers.

At present the crude oil production of the United States, Venezuela, and the Middle East accounts for 81% of the world total, and these same countries have 86% of the proved reserves. They are responsible for practically all of the increases in petroleum output and proved oil reserves since 1940. The total petroleum output of the remaining producing countries is substantially less than it was before the war.

Although exploration work is under way in regions of South America other than Venezuela and Mexico and China, there is no reason to believe that production of these regions – or other regions being explored – will soon compare with the production of any of the three leaders. The development of any large petroleum reserves discovered outside the United States will take years.

Before the war, Russia and the East Indies were the chief oil-producing regions other than the big three. Now Russian production is believed to be from 450,000 to 500,000 bbl daily – approximately two-thirds of the peak figure for the late thirties. This includes the Soviet-dominated areas of other countries in central Europe, whose production is considerably below prewar levels.

RUSSIAN RESOURCES A MYSTERY

Geologists agree that Russia has a large part of the world's oil area, but little is known about the success of recent prospecting. The Germans destroyed oil properties in western USSR, but the most important sources in the Caspian Sea area and eastern and northern supplies were untouched.

The Soviet government's aim is to triple present production in order to supply enlarged domestic needs and to become a seller in world petroleum markets. This program probably can not be carried out quickly because Russia has depended on the United States for much of her petroleum equipment and technology. Although the Soviet government, at least until recently, has been an important buyer of equipment and supplies from this country, it has not obtained all the equipment needed for rehabilitation and expansion of its oil properties, particularly for refineries.

Two years after the end of World War II, oil production in the Far East was only about 25% of the 1938 figure. Unsettled political conditions in the East Indies and Burma, where the bulk of Far East crude was produced, have delayed American, Dutch, and English owners in their rebuilding programs. At least two more years will be needed to restore oil operations in the Far East to prewar levels.

(Paper "The Geography of Oil," was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 7, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Income-Expense Pattern Holds for Air Transport

Based on paper

By R. G. FERGUSON

Pan American Airways, Inc.

EXPANDING volume of air transport business lowers unit ground-operating costs, records of domestic carriers show.

History of American Airlines, United Airlines, and Eastern Airlines illustrates the point. American increased its operations between 1939 and 1945 from about 22 million to 102 million revenue ton-miles. During this same period its ground operating expenses came down from 26¢ to slightly more than 20¢ per revenue ton-mile.

United increased its production from 19 million revenue ton-miles in 1939 to 88 million in 1945, while its unit ground-operating costs dropped from 29¢ to about 19¢. Eastern Airlines followed the same pattern.

Despite the wage and price-level spiral in the past two years, drop in unit ground-operating costs with rising business volume held true. This is shown in Fig. 1. Here's what this chart tells us about American Airlines' costs and volume:

a. During first six months of 1946 - volume averaged 10,138,000 ton-miles and costs increased to 29.5¢.

b. In July - production was 12,834,000 ton-miles with costs of 27.7¢.

c. In August - 14,241,000 ton-miles of volume reduced costs to 25.9¢.

d. In September - increase in level to 15,312,000 ton miles lowered unit costs to 23.9¢.

e. In January - volume dropped to 10,600,000 ton-miles and unit costs rose to 38.2¢.

f. And as of June, 1947 - an upswing in revenue ton-miles to 13,919,000 again lowered costs to 27.3¢.

Figures for the other two airlines follow along similar lines.

Trend line of American Airlines' experience, plotted in Fig. 2, shows unit costs react to volume as a straight line. It shows the trend for experience to date only. But as volume rises still further, the unit-cost curve will assume an asymptotic form at some value of volume. Increased volume beyond that point will have little or no effect on unit ground operating costs.

Although the industry hasn't reached this point yet, it will differ for each airline because of many imponderables connected with this minimum ground operating costs per unit.

(Paper "Air Transport Ground Operating Costs," was presented at SAE National Air Transport Meeting, Kansas City, Dec. 2, 1947. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members 50¢ to nonmembers.)

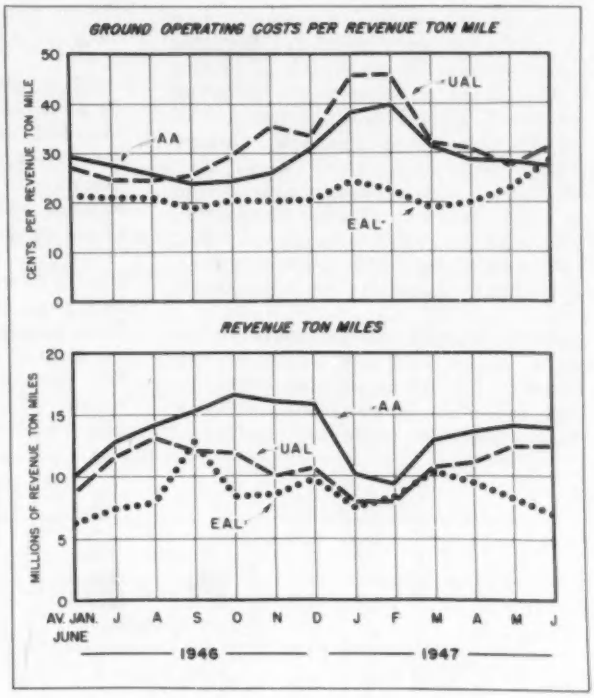
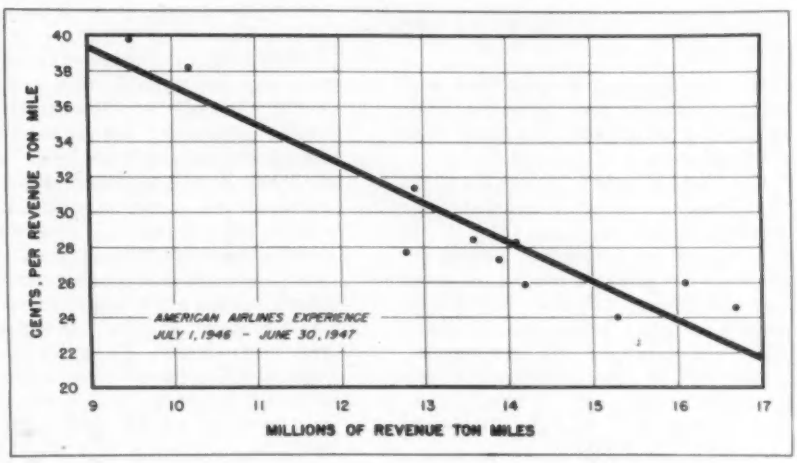


Fig. 1 - Correlation of unit ground operating costs and volume of revenue ton miles of American Airlines (AA), United Airlines (UAL), and Eastern Airlines (EAL)

Fig. 2 - American Airlines' ground operating costs decreased along a straight-line trend as its ton-mileage rose



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Rapid Growth of Brazil Helped by Air Transport

Based on paper

By RALPH N. DuBOIS

Aeronautics Institute of Technology of Brazil

AIR transportation may do for Brazil what railroads did for the development of the United States.

Brazilian airways are beginning to reach localities not connected by ground transportation. Except for competing airlines, air travel enjoys a monopoly in these places. In fact, Brazil's railway mileage is equivalent to this country's in 1855, its highway transport situation on a par with ours in 1907.

There are 70,000 scheduled airline miles and 600 airports in Brazil, 120 of which are suitable for DC-3's. Brazilian airline operators want aircraft satisfying needs of feeder lines, which are doing much to develop new territories. They would like a three-engine utility plane for passengers and freight that cruises at 90 to 125 mph and carries 4500 lb useful load.

Private aircraft and air taxi service are especially important forms of transportation for Sao Paulo, one of the great farming states. Almost every coffee, cotton, and cattle plantation there has a landing strip. For many it's the gateway to the outside.

While unskilled labor is readily available, Brazil sorely lacks trained mechanics and engineers. But technical schools using American teaching methods are making headway toward remedying this manpower shortage. (Paper "Brazil and Air Transport," was presented at SAE Annual Meeting, Detroit, Jan. 15, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Secondary Car Motions Disturb Ride Smoothness

Based on paper

By R. R. PETERSON

Chrysler Corp.

CAR ride discomfort derives much help from secondary motions stemming up from unsprung mass components.

Over small road irregularities the entire car tends to be sprung only on the tires. It oscillates at a natural frequency of about 200 cpm and subjects its passenger to the "boulevard jerk" or tire harshness - much like a rubber-tired hay wagon.

New extra-low pressure tires greatly reduce this ride roughness because of their increased static deflection.

Wheels, axles, and other suspension components divorced from the primary sprung-mass system form light secondary systems, sprung stiffly on the tires and chassis springs. They're subject to relatively high natural-frequency vibrations which are excited strongly by minor road disturbances.

Directly or indirectly secondary system vibrations excite a whole family of low-amplitude high-frequency motions in the car body called "shakes." Shake motions are tough to deal with because soft mountings to provide low natural frequencies aren't permissible in many cases. Stiff-enough attachments to bring about natural frequencies much higher than natural frequencies are necessary. This is a poor expedient. (Paper "Basic Principles of Automobile Suspensions," was presented at SAE Canadian Section, Toronto, Nov. 19, 1947.)

Tractor Demands

Based on paper

By C. W. CANNON and EARLE COX

Allis Chalmers Mfg. Co.

LOCATING tractor seats ahead of the rear axle and suspending them on variable rate springs will make biggest improvement in operator ride comfort.

Let's prove the comfort-location criterion by relating seat movement to front and rear axle motion. First assume the operator is riding on a solidly mounted seat, such as in Fig. 1. Calculations tell us that a bump with surface 45 deg to the horizontal produces maximum vertical shock on the tire. (The tire is considered to be a group of radial springs which transmits shock imposed on it to the front axle.)

If the front tires hit a 6 3/4-in. bump at a 10-mph tractor speed, the axle centerline rises nearly 20 in. and drops 3 1/2 in. below normal running position. Such bump will raise the rear-axle centerline only 5 1/2 in. and drop it 3 1/2 in. Fig. 2 charts the shock on front and rear axles. Small bumps reduce shock, the tire always contacting the ground. Right-hand end of the shock curves show such condition.

Geometry of Fig. 3 reveals a 30% greater shock and displacement at point "A" than at the rear-axle centerline. For this particular seat position, rear-wheel motion imposes twice as great a shock on the operator as does front-wheel motion.

Now we have the data to find best location for minimum shock. Fig. 2 shows maximum shock at front-wheel centerline to be 183 G per sec and at rear-wheel centerline, 67 G per sec. Amount of shock transmitted from either axle position varies inversely with the distance between riding position and axle centerline. Therefore, for minimum shock the seat should be located between front and rear axle.

Let's take some distance, X,

Ride Comfort Seat Redesign

ahead of the rear axle where shock is a minimum. Then

$$\frac{67}{X} = \frac{183}{87 - X}$$

$$X = 23.3 \text{ in.}$$

Locating the seat 23.3 in. ahead of the rear axle would transmit minimum shock to the operator. Its value would be $\frac{67(86 - X)}{87}$ or 49 G per sec. This seat relocation reduces shock on the operator by 50%. Although it's impossible to relocate most tractor seats this way, they should be placed as near as possible to optimum position after due consideration to visibility, tractor control, and mounting ease.

Seat-suspension designers also make a mistake in using a stiff spring. The stiffer the spring, the greater its shock-transmitting ability. Since these springs generally have a natural frequency above either the forced or natural tire vibration, they never vibrate in the resonant range. Therefore, tire-imposed shocks on the tractor reach the operator almost undimished.

The designer should use a variable-rate seat suspension with a small rate for small loads. If the suspension's natural vibration frequency falls within range of forced frequency on it, a shock absorber is called for.

The fact that over 50% of 110 tractor operators surveyed expressed dissatisfaction with the tractor seat and that 12% of them changed the original manufacturer-supplied seat indicates they want a more comfortable seat. Inexpensive and superior-riding seats can be designed by making analyses such as this one.

(Paper "A Practical Approach to Operator's Comfort," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 18, 1947. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.) TURN TO PAGE 90

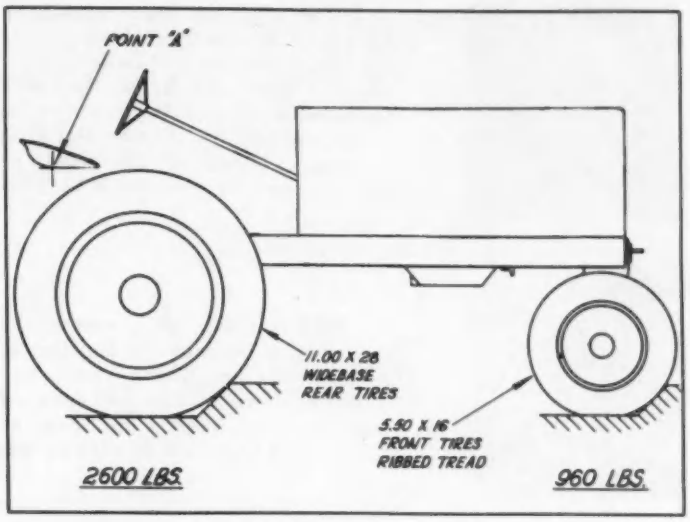


Fig. 1 - How much shock is transmitted to point "A" and what's the most comfortable seat location can be found mathematically

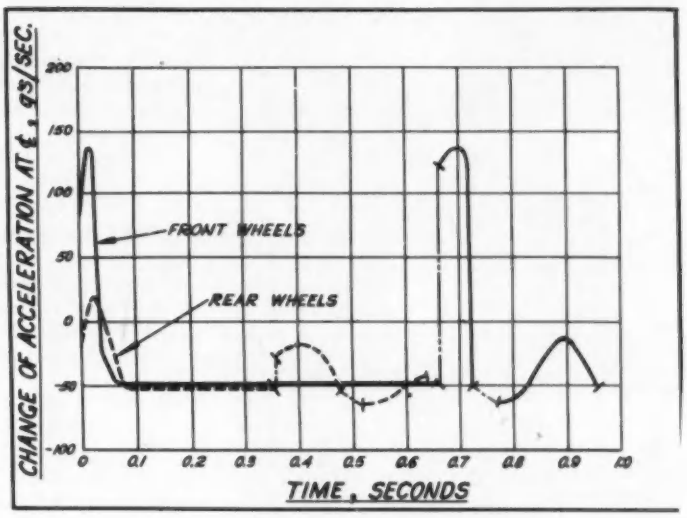
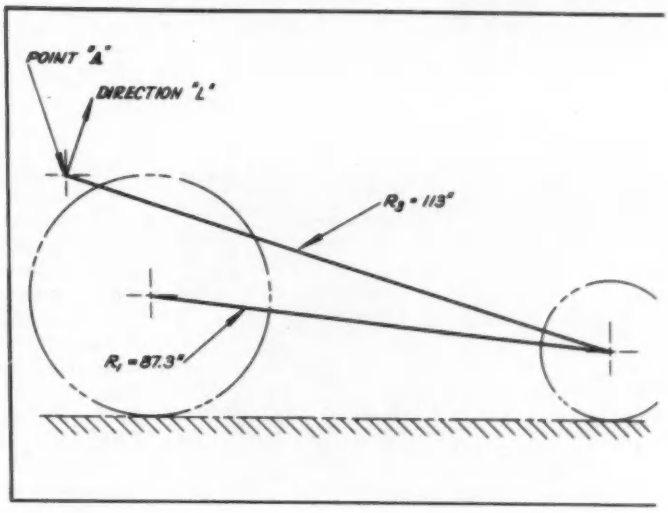


Fig. 2 - Shock at front and rear axle from striking same size bump

Fig. 3 - Tractor and seat geometry for rear-axle displacement



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About S

J. L. McCLOUD has been appointed executive engineer at the Ford Motor Co., Engineering Laboratory in Dearborn, Mich., to succeed the late R. H. McCARROLL. He had been head of the Department of Chemical Engineering at Ford. McCloud is 1948 vice-president of the newly-authorized Engineering Materials Activity.

J. CARLTON WARD, JR., was elected chairman of the Fairchild Engine & Airplane Corp. President since 1940, he continues as chief executive officer. Ward will continue to head the NEPA project on nuclear energy to aircraft propulsion.

DR. RAY P. DINSMORE, vice-president in charge of research for the Goodyear Tire & Rubber Co., will be presented the Colwyn Gold Medal for 1947 by the Institution of the Rubber Industry. He will receive it in London on June 25, in recognition of his work in synthetic rubber research, development and application to the product.

JAMES E. P. SULLIVAN, treasurer of the SAE Dayton Section was recently, by unanimous action of the Dayton City Commission, appointed to the Solicitation Advisory Board of the City of Dayton. He is a laboratory engineer for Chrysler Airtemp.

D. L. WERTZ has established a manufacturers agency in Detroit covering the State of Michigan and the City of Toledo. The agency will represent the Upton Furnace Division of Commerce Pattern Co. of Detroit, the John Ek Industries, and the Crown Chemical Co. of Guilford, Conn.

J. GEORGE OETZEL, left, has been elected a vice-president of Warner Electric Brake Co., Beloit, Wis. FOREST C. HILE, center, is now chief engineer of the company's Automotive Division and FRANK G. BORN is chief engineer of the Production Division.

DE OWEN NICHOLS, JR., is now located at the University of Michigan, Ann Arbor, as an associate professor in the Department of Mechanical Engineering.

Among the members of the general committee in charge of the Third Symposium on Combustion and Flame and Explosion Phenomena at the University of Wisconsin, Sept. 7 to 11 are SAE members DR. F. G. BRICKWEDDE and DR. E. F. FIOCK, National Bureau of Standards; DR. GEORGE CALINGAERT and WHEELER G. LOVELL, Ethyl Corp., and A. M. ROTHROCK, National Advisory Committee for Aeronautics.

JOHN R. BARTHOLOMEW has been promoted to assistant sales manager of the Eaton Mfg. Co. He has been connected with Eaton since 1935.

J. F. WINCHESTER, president of the Davisbilt Products Co., Cincinnati, Ohio, and director of Liberty Products Corp. and Ambell Co., Inc., New York City, is making an extended trip through the Latin American countries. He is a past-chairman of Metropolitan Section and a past vice-president of the Society.

Recently elected president of Maysteel Products, Inc., CLINTON E. STRYKER has been president of Adel Precision Products Corp. and Aerco Corp., Burbank, Calif.

A. H. WINKLER, JR., has been appointed chief engineer of the Bendix Stromberg Carburetor Department.

J. H. (JIM) COOVER has been promoted to the position of manager of production and research for D-A Lubricant Co., Inc., Indianapolis, Ind. For the past four years, Coover was chief chemist for this company.

t SAE Members

REHMERT W. CLARK, who had been consulting engineer with the Trundle Engineering Co., Cleveland, is now factory manager for the Planet Corp, in Lansing, Mich.

On April 12 CHARLES B. SPACE, a past chairman of the SAE Syracuse Section, was installed as president of the Technology Club of Syracuse. Space, who is the first SAE member to be so honored, is chief engineer of the Clutch Division of Lipe-Rollway Corp.

On March 26 General Motors Corp. received its fourth award of honor for distinguished service to safety, from the National Safety Council. C. E. WILSON, president of General Motors, received the award at a special luncheon in Detroit.

No longer affiliated with Moore Brothers Fleet in Houston, Tex., TONY G. WHITENER has become general manager of Associated Factory Representatives in Dallas.

Prior to becoming dynamometer testing engineer for the General Motors Corp. in Detroit., CHARLES E. NADEAU was associated with Continental Motors Corp.

Previously a graduate student at the Harvard University Graduate School of Business Administration, WILLIAM MAXWELL SCRANTON recently became connected with Pratt & Whitney Aircraft, Division of United Aircraft Corp. in East Hartford, Conn.

Recently becoming a junior test engineer with the American Gas Association in Los Angeles, WILLIAM FREDERICK ROBERTS had been a machinery salesman for Hughes Sales Co., same city.

Formerly a production manager for Robert Elder, Ltd., Toronto, Ont., Canada, WALTER DALE is now body engineer for Canadian Top & Body in Tillbury, Ont.

HANS A. BOHUSLAV recently became vice-president in charge of engineering and production for Engineering Controls, Inc. in Los Angeles. Prior to this post he was connected with the Sterling Engine Co. in Buffalo, N. Y. At present he is vice-chairman of the Diesel Engine Activity for the SAE Northern California Section.

SAE MEMBERS IN THE NEWS

PAUL G. HOFFMAN, left, president of Studebaker Corp. and chairman of the Committee for Economic Development, being greeted in the Capitol by Sen. Arthur H. Vandenberg, foreign relations committee chairman, after the Senate had approved unanimously his appointment as Administrator of Economic Cooporation by President Truman. Hoffman will direct the U.S. foreign aid program.

GROVER LOENING received the Medal of Merit from Gen. Carl Spaatz, until recently Chief of Staff of the U.S. Air Force, on Jan. 12. Loening, who was the War Production Board's adviser on aircraft and chairman of the Helicopter Committee of the NACA, is chairman of the Board of Roosevelt Field, Inc., Garden City, L.I., N.Y.

The Firestone Tire & Rubber Co. has received its third Award of Honor for Distinguished Service to Safety from the National Safety Council. J.E. TRAINER, right, Firestone vice-president of production, received the award from William A. Irvin, chairman of the Board of Trustees of the National Safety Council.

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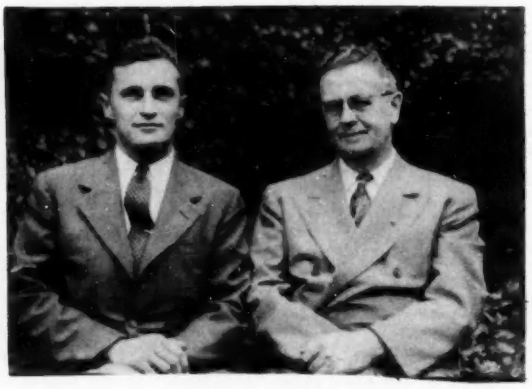
SAE Fathers and Sons . . .

At the left, is IRVIN FOGG RICHARDSON, who is railroad service engineer with Socony-Vacuum Oil Co., Inc. in Medford, Mass. His son, SEWALL FOGG, is power plant installation engineer with the General Electric Co. in Lynn, Mass.

PAUL B. KIMMEL, sales manager of the Balas Collet Mfg. Co. in Cleveland, Ohio, and his son, PAUL JR. He is at present a senior at Ohio State and is head of the Mechanical Drawing Department at Columbus Boy's Trade School in Columbus, Ohio. During the war he served as an engineering officer in the U. S. Navy.



At the left is CLAUDE E. BRODERS, general superintendent of the Govro Nelson Co. in Detroit, Mich. With him is his son CLAUDE O., who is a designer for Pratt & Whitney Aircraft Division, United Aircraft Corp., East Hartford, Conn. At present he is secretary of the SAE Southern New England Section, a post he has held since 1946. He was also that Section's SAE Journal field editor in 1944.

SAE Members Said. . .

"The rebuilding of an adequate transportation system throughout Western Europe is certainly one of the key factors in making a success of our efforts there". . . JAMES D. MOONEY, president and chairman of the board, Willys-Overland Motors, at the 25th annual meeting of the Great Lakes Regional Advisory Board, March 24 in Toledo, Ohio.

On receiving the General William E. Mitchell Award, presented by Aviators' Post #743, American Legion, in New York City on March 3, JAMES H. DOOLITTLE, vice-president, Shell Union Oil Corp. . . . "The fundamental fault with our National Defense Establishment today, is, despite unification, it still consists of three imperfectly coordinated agencies, three competing teams - the Army, the Navy and the Air Force."

HUGO H. HAAS has been appointed civilian head of the Internal Combustion Engine Section of the Bureau of Ships, in charge of diesel and gasoline engines. Previous to joining the Navy Department, he was in charge of diesel engine and marine equipment, designs of diesel operated vessels, in the office of the Chief of Engineers, U. S. Army, for about 20 years.

Sale of Aircooled Motors, Inc., Syracuse, by Republic Aviation Corp. to Tucker Corp., Chicago, was announced by C. F. B. ROTH, Aircooled president. No change in management or location is contemplated. Current aircraft engine demand requires use of less than half of the plant's productive capacity, and the unused portion will be available for the Tucker engine.

Now a mechanical engineer in the Automotive Division of the Research Department at Socony Vacuum Oil Co., Inc., Paulsboro, N. J., WAYNE W. CARTER has been in the Research Department of the Elliott Co. in Jeannette, Pa.

OLIVER CORP. PROMOTIONS

C. L. HECKER, general manager of South Bend plants, has been promoted to vice-president in charge of manufacturing at South Bend, Shelbyville and Springfield plants. O. E. EGGEN, director of engineering was elected to the vice-presidency of the company.

HECKER

EGGEN

HERBERT B. FORD, formerly project-detail engineer, AC Spark Plug Division General Motors Corp., has now been appointed service training instructor with GMC Truck & Coach Division, General Motors Corp. of Oakland, Calif.

ALBERT P. ELEBASH, formerly division engineer, Pan American World Airways, Inc., has been appointed assistant sales and service manager of the B. G. Corp., New York City. A former member of the Metropolitan Section Governing Board, he has been author of a number of SAE papers.

JEROME LEDERER, chief engineer for Aero Insurance Underwriters, has been elected president of the Flight Safety Foundation, New York.

GEORGE E. ROWBOTHAM has resigned from the Fisher Body-Ternstedt Division of General Motors Corp, where he served as project engineer and chairman of the General Motors Drafting Standards Subcommittee. He has accepted a position as standards engineer with the American Coach & Body Co. Rowbotham is very active in SAE work.

WHEELER G. LOVELL, for the past 21 years assistant head of the Organic Chemistry Department of the General Motors Research Laboratories, has joined the Ethyl Corp. Research Laboratories in Detroit as an associate director of research in the basic combustion field.

HERB PACKER, editor of Motor Service Magazine for the past 18 years, has announced that this connection was discontinued on Jan. 31. His future plans are not definite, but after a bit of relaxation and travelling he will probably affiliate again with some activity connected with the automotive after market. WILLIAM K. TOBOLDT has taken over the position as editor of that magazine, after being with the Chilton Co. for 23 years.

CONTINUED ON PAGE 91

WILLIAM J. CRONIN has been appointed managing director of the Automobile Manufacturers Association, succeeding GEORGE ROMNEY, who resigned to become assistant to GEORGE W. MASON, president of Nash-Kelvinator Corp. Cronin joined AMA in 1933, from the Tri-City Manufacturers Association, Moline, Ill.

WILLIAM J. CRONIN, left

GEORGE ROMNEY, right

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MORE good Section reports by SAE Field Editors have been necessarily condensed for broad (although inadequate) coverage. Reports were varied and interesting, and SAE Journal regrets its inability to publish them in full pending settlement of the typographical union's strike.

PITTSBURGH, CHICAGO, and CANADIAN Sections played host to President Pigott. In Pittsburgh, on Feb. 24, he shared the podium with E.M. Barber, Texas Co., who gave his previously-presented paper on "The Elimination of Combustion Knock." Here Pigott told of the need for continued cooperation between petroleum technologists and engine designers to solve problems of more economical use of fuels.

Singled out for close cooperation were higher compression ratios, use of supercharging, and water-alcohol injection at peak loads. Pigott foresees no early use of gas turbines because of the vast amount of development work ahead.

Barber reported that a diesel engine has been built to burn fuel so completely that its exhaust is smokeless and odorless.

On March 9 in Chicago, Pigott reported that both oil and automobile industries are extremely economy-conscious, that getting oil out of shale is too costly, and that most synthetic oils and gases waste too much of the power of the original materials.

Some future possibilities for

DETROIT. Shown at the reception at Detroit Section's Feb. 2 meeting are A.C. Hazard, Speaker Andrew Kalitinsky, and C.F. Bachle

DETROIT. V.C. Young (left) receiving from Chairman Robert Insley a certificate of appreciation for his services as last year's chairman on Feb. 16

PITTSBURGH. Col. J. Frank Drake, left, president of Gulf Oil Corp., with Past-President A.T. Colwell, and President R.J.S. Pigott, taken March 23 when the Pittsburgh Section honored the SAE president in his home town with a banquet attended by more than 300 distinguished guests and SAE members. Colwell, main speaker, was introduced by Toastmaster John W. Orr, and Section Chairman Wallace Hallam presided. High praise of Pigott's engineering ability and leadership and presentation of a chronograph from the Section, was followed by Colwell's predictions of near and long term developments of the industry. "Being SAE president," Pigott said, "is one of the few durable satisfactions in life"

SOUTHERN CALIFORNIA. Speaker J.C. Miller (center) talking with Section Chairman L.D. Bonham (right) and other Section members after giving his paper on "Natural History of the Crankshaft", Feb. 26

saving fuels, he said, are: higher compression engines, use of dual fuels, high-compression diesel engines, and use of superchargers.

At the same meeting, Eugene S. Goebel, sales manager of Motorola, Inc., illustrated radiotelephone communication systems as they are available today, and A. D. Gilchrist, chief engineer of Leece-Neville Co., described the electrical power systems in use.

Goebel predicted that in the near future it will be possible to drive from coast to coast and yet be in constant touch with the point of origin.

Gilchrist said that for radiotelephone work maximum power generation at slow speeds is necessary because in many applications, such as taxis, buses, and police cars, power is needed

TURN TO PAGE 84

CANADIAN. President Pigott receiving an English umbrella cane from Canadian Section members. Left to right: Chairman Ed F. Armstrong; Secretary Clifford E. Phillips; Vice-Chairman Warren B. Hastings; President Pigott; Treasurer W.W. Taylor; and W.E. McGraw, member of the National Nominating Committee.

PARKS COLLEGE. Present at the December meeting of the newly-organized SAE Club at Parks College were Neils C. Beck, assistant dean and vice-chairman for Students of St. Louis Section; St. Louis Section Chairman Robert Slattery; and 1947 President C.E. Frudden

SOUTHERN NEW ENGLAND. SAE President R.J.S. Pigott celebrated his birthday in Hartford, Feb. 4. Left to right are Norman G. Shidle, Pigott, Section Chairman Richard C. Molloy

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SAE Section

BINGHAM

. . . . of Virginia

Lucian W. Bingham has been a truck salesman and dealer for more years than he cares to admit. Born in Vermont, he managed to find his way to Virginia where he farmed for a while until he entered the automotive industry by way of International Harvester Co. After 17 years he left to join Sterrett Operating Service, taking over the Richmond branch about 1939.

This transplanted "Damyankee" is now a full-fledged son of the Old Dominion, although it is suspected that he still votes the Republican ticket in national elections.

"Bing's" principal hobby is football, and he will travel miles to see a game. This hobby proved right expensive last fall when Mrs. B. found out how much he spent on season tickets for the Washington Redskins, Richmond Rebels, and University of Richmond games. She decided that if Bing could spend that much on football, he could afford to have the house done over from top to bottom. Season tickets for 1948 games will be mailed to his office.

-by Jean Y. Ray

POWELL

. . . . of Indiana

If you ever saw 2-year-old Penny Lee Powell taking things apart you'd know she's following in the footsteps of her mechanically-minded dad, William S. Although Penny doesn't put things together yet, she will, and will eventually dream of gadgets of her own if she's anything like Bill.

The depression interrupted Canadian-born Bill's education. He bridged hard times with assorted jobs - service station attendant, electrical-appliance shop foreman, department store display and sales worker, lab technician.

He got his foothold in engineering as a layout engineer with Chevrolet's Commercial Body Division in Indianapolis in 1936. Four years later he joined Merz Engineering Co., and rose from plant engineer to chief engineer. Since 1944 he has been vice-president and chief engineer of Laboratory Equipment Corp.

He enjoys his job as chief timer of the AAA Indianapolis Motor Speedway and other AAA events. He's also official stop-watcher for Detroit Yacht Club regattas. Bill likes water sports, too. Swimming, any kind of boating, and ice skating bring out the athlete in him.

-by R. T. Jackson

HALLAM

. . . .of Pittsburgh

As a business man, Wallace Hallam realizes that other men also work during the day, and prefer meetings that "get started, get going, and get done" - a program that has proved very popular with Pittsburgh Section members.

He is a hard worker, and his example has been contagious to committee members. Fleet operator Hallam wisely chose a research man as program committee chairman, to insure a well-balanced program.

Hallam studied production management and motor truck transportation at Washington University, and entered the automotive industry in 1916, via Garford Truck Co. Since then he's been with Autocar Co. and White Motor Co., and is now district manager for Mack-International Motor Truck Co.

-by Murray Fahnestock

FRANK

. . . . of Central Illinois

Richard S. Frank has a good deal of load-carrying capacity, as evidenced by his energetic activities on behalf of both Caterpillar Tractor Co. and SAE. He brings to both organizations, too, an extreme practicality combined with aggressiveness in developing suggestions and ideas for improvements.

Frank, a design engineer with considerable experience in diesel, gasoline, natural gas and dual-fuel engine design, manufacture and research, has so far been a one-company man. He joined Central Illinois Section soon after it was formed (as Peoria Group) in

Lucian W. Bingham

W. S. Powell

Wallace Hallam

Richard S. Frank

Chairmen

Seven more biographies... written by SAE Journal Field Editors

Tom Hendrickson

W. E. Briece

Fredric Flader

HENDRICKSON

. . . . of Twin City

Tom Hendrickson's career has run the gamut of vehicle engineering. Tractors, airplanes, and cars have kept him busy at one time or another since he started to push a slipstick for pay back in 1910.

He started his engineering career in the tractor business with the Gas Traction Co.'s Big Four Tractor Works in Minneapolis. It looked as if Tom was going to stick to the farm machinery field because in his next job he was field engineer and special representative for Bull Tractor Co., builders of the first two and three-plow tractors.

But came World War I and Tom became curious about those flying machines. He served as chief inspector of aircraft engines for the Signal Corps' Bureau of Aircraft Production in the Flint and Detroit areas. Later he was attracted to the motor vehicle field, working for Bethlehem Motors and Dusenberg Motors. Since 1921 he's been with Pure Oil Co., as division lubricating engineer and manager of the Industrial Oil Department.

He's been an SAE member since 1927. For Twin City Section he has been publicity director, secretary, treasurer, and vice-chairman. When he isn't busy with Pure Oil duties and Twin City Section affairs, Tom manages to get in some hunting, fishing, and gardening.

-by Reed Hedges

BRIECE

. . . . of Kansas City

Whenever or wherever anything is doing in the Kansas City area involving aviation, Bill Briece is certain to be there, and in good form. This was evidenced pretty clearly during the recent National Air Transport Meeting held there. He is, too, very active in aviation organizations in the area. He is a member of the executive committee of the Chamber of Commerce's Aviation Department, chairman of the Non-Scheduled Aviation Committee, and member of its legislative committee. His extracurricular aeronautic activities don't stop there, and he is also a 32nd degree Scottish Rite Mason.

When he isn't working energetically in the interests of the SAE or one of these other numerous organizations, Bill works equally hard at being Pacific Airmotive Corp.'s branch manager.

-by John W. Vale, Jr.

FLADER

. . . . of Buffalo

Fredric Flader's friends say he must have been delivered by a jet-propelled stork to his folks in Antonito, Colo. in 1897. Ever since his graduation from Carnegie Tech Fred has had the aviation bug.

The years leading up to 1944, when he formed Fredric Flader, Inc., he spent growing with aeronautical engineering. He started as a civilian engineer at the Army's McCook Experimental Field Station. After a period as project engineer on flying boats and on the Commodore Transport, he became assistant chief engineer of the Keystone Division, Curtiss-Wright Corp. He progressed to chief engineer of the corporation's Airplane Division in Buffalo before he went into business for himself.

Fred's company is busy at its new home in North Tonawanda developing and building gas turbines and axial flow compressors. It is also developing instruments for aircraft guided missiles, and nuclear energy equipment.

Fred has traveled the far corners of the world in connection with his work, including battle zones of Asia and Europe. Besides being an SAE member since 1924, he's a lieutenant-commander in the U.S. Naval Reserve, a Fellow in the Institute of the Aeronautical Sciences, and a past-president of the Buffalo Aero Club.

-by Robert Best

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while the vehicle is standing with the engine idling.

In Toronto, on March 17, Pigott spoke on "The Supercharger and the Engine," and was given an English umbrella cane by Section members.

Engines had the spotlight, too, at SALT LAKE CITY Group, March 2, and BRITISH COLUMBIA Group March 8. Frank R. Elliott, automotive and fleet engineer for Ethyl Corp., reported to both Sections that today's automobile engine has 92% more horsepower, runs 35% faster, and is only 2% larger than the engine of 1925. He pointed to valves as probably the most important and most abused item in the engine. Very little thought, he said, has been given to temperatures at which valve seats operate. Valves, usually, don't warp but follow valve seats.

Particularly important in controlling valve temperatures, Elliott said, are correct ignition and air-fuel ratios. Ignition timing is the most important adjustment on any engine; it becomes more important as engine compression gets higher.

According to Elliott, automotive fuels still are largely in the experimental stage. Above 100, performance numbers are used rather than octane rating figures. Engines using two fuel systems and two-float carburetors are being studied.

WILLIAMSPORT Group members heard on March 1 how cracking processes have increased the amount of gasoline available from crude oil to the point where a very high percentage can be used as fuel for gasoline engines. W.G. Perriguey of Esso Standard Oil Co.'s Automotive Fuels Division, blamed the current fuel shortage on consumed quantity catching up to ability to produce, and on an imperfect distribution system.

To correct these conditions, he said, the petroleum industry is spending $4,000,000,000 on increased facilities for producing, transporting, refining and marketing.

He feels that new discoveries and the availability of synthetic oil from natural gas, coal, and shale, will keep production in step with demand. The industry expects to be able to meet all quantity and quality requirements of the automotive operator if the importance of conservation is realized.

SAE members in SYRACUSE joined the Technology Club on March 15 to hear Joseph Geschelin, Chilton Co.'s Detroit editor, discuss 1948 cars and preview some future design trends.

Geschelin picked for comment such developments as new bodies on Hudsons, Cadillac and Olds Series 8-98 models, and Packard Clippers, Buick's Dyna-flow transmission, new Hudson Six engines, and industry-wide adoption of super-balloon tires.

Smaller-displacement, ultra-high-compression type engines were spotlighted in the future picture, and attention was directed to development of the 150-hp gas turbine as a possible competitor to reciprocating engines for motor trucks and possibly passenger cars.

The SAE Annual Meeting in Detroit was reported to members of COLORADO Group in February by George Gromer, supervisor of motor vehicles for Mountain States Telephone & Telegraph Co., who also criticized new truck models from the operator's standpoint. Bodies and special body design are as important in trucks for utilities, in his opinion, as the truck chassis and engine.

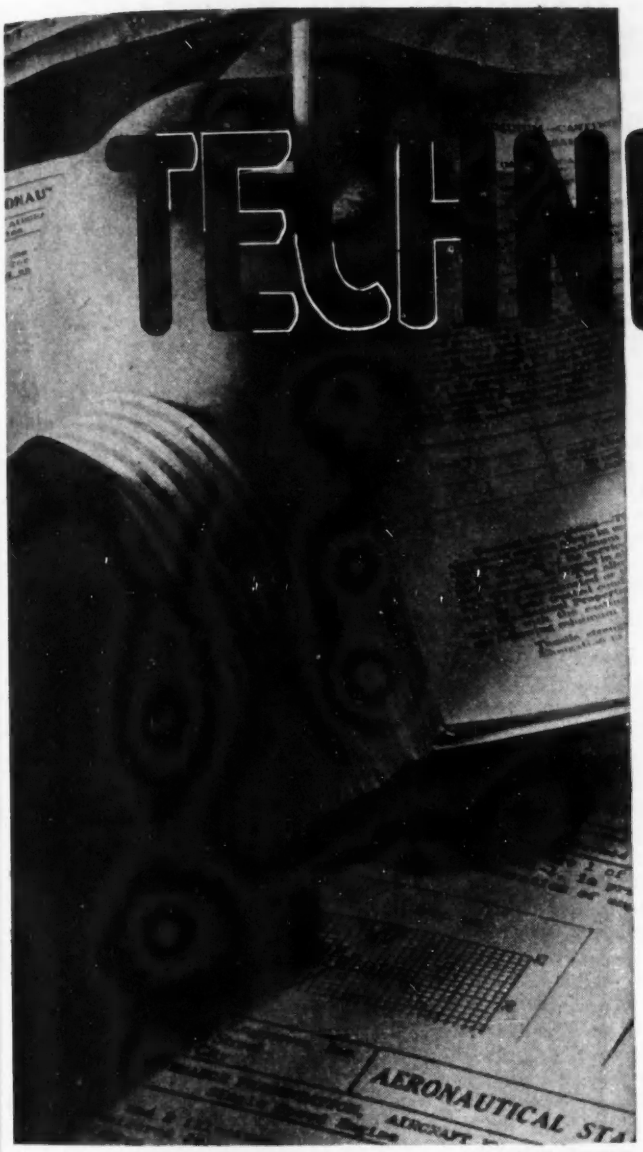
MID-CONTINENT Section members learned on Feb. 6 about design and installation of the "Thermatic" booster heaters developed for use on GMC trucks and coaches, which have achieved good success in reducing cold sludge, dilution, corrosion, and wear, and in facilitating starting in extremely cold weather.

Tore Franzen of Chrysler Corp. used coil springs and bars with movable weights to acquaint ST. LOUIS Section members with effects of load distribution and harmonic action on March 9, when he spoke on "Spring Suspension Systems."

METROPOLITAN. Above: W. C. Lawrence, Section vice-chairman for Air Transport (left) with Dr. Hugh Dryden, NACA director of aeronautical research, who was principal speaker at the Feb. 18 meeting.

Below: Charles S. Herrmann (left) who presided at the Feb. 25 Panel Meeting on two-way radio, with D. S. Brown, one of the AT&T engineers who discussed the prospects of this type of installation for vehicles

CONTINUED ON PAGE 89



TECHNICAL COMMITTEE PROGRESS

SAE Publishes Manual On Cooling Systems

THE recently-published SAE Manual, "Maintenance of Automotive Engine Cooling Systems," is designed to serve as a text book for students and as a reference for both mechanics and vehicle drivers.

An outgrowth of a wartime report on motor vehicle maintenance, prepared for the Army, Navy, and other government agencies by an SAE Transportation & Maintenance Committee group, this 100-page Manual covers these five cooling system phases: (1) theory of its operation, (2) how to keep it functioning properly, (3) all possible troubles, (4) how to detect them and, (5) how to correct them.

One of its first chapters offers a new approach to construction, function, and operation of the cooling system. Practical rather than academic discussions give the student a sounder foundation for subsequent maintenance instructions. Another special feature covers in considerable detail the physical and chemical properties of water and antifreeze solutions and their influence on cooling system operation and maintenance.

It drives home to the driver the importance of his role in preventive maintenance. It tells him that he should observe engine operating temperature, coolant level, and leakage to

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anticipate need for preventive maintenance before trouble develops.

Another chapter analyzes causes and effects of cooling-system components' malfunction and failure. Illustrations show typical failures. The Manual stresses preventive rather than corrective services.

A practical trouble-shooting system offered will pay dividends to the mechanic. It tells him how to find the cause in the shortest time, with the least work, and without overlooking anything - even in the most complicated cases.

Following each detailed inspection and test in the order prescribed will guide the mechanic to most common and easily-found causes first. By correcting troubles when found before going further, he will eliminate guesswork and duplication of labor.

The Manual is a compilation of results of extensive test work by leading engine cooling authorities, vehicle builders, coolant manufacturers, and truck and bus fleet operators. Its wartime predecessor served as a basic instruction and operating manual for Army Ordnance, Office of Defense Transportation, and other groups.

The new Manual has been revamped thoroughly for postwar civilian use and brought up-to-date with most recent developments. It's available from SAE Special Publications Department. Price: $1.00 to members, $2.00 to nonmembers. Quantity prices are available.

The SAE Cooling System Maintenance Subcommittee, which authored both the original Manual and the present version, was chairmanned by D. H. Green, National Carbon Co., Inc. Serving with him were J. S. Ahrens, National Carbon Co., Inc.; Edward Chadwick, Chadwick Radiator Repair Co.; H. L. Corkan, E. I. duPont de Nemours & Co.; G. D. Ford, Railway Express Agency, Inc.; L. R. Gwyn, Jr., The Overseas Equipment Corp.; E. H. Keller, E. I. DuPont de Nemours & Co.; J. J. McCarron, Consolidated Telegraph & Electric Subway Co.; S. G. Page, Equitable Auto Co.; and H. A. Reynolds, Harrison Radiator Division, GMC.

Parts Design Critical For Frigid Operation

UTMOST design simplicity of equipment is just as important as the material it's made of for successful arctic-zone performance, it was brought out in an investigation of low-temperature properties of ferrous castings by a group of the SAE Iron & Steel Technical Committee.

A report of comments by W. S. James, Fram Corp., concerning his experience at Studebaker in developing the Army Weasel for sub-zero operation emphasized the point. James views metal behavior at these temperatures as an engineering as well as a materials problem.

He says conditions in the Arctic are so different from those we're accustomed to that the engineer cannot design suitable equipment unless he visualizes them, regardless of materials on hand. The design should be as primitive as possible.

For example, an ordinary buckle is entirely useless under arctic conditions; but a loop and knot replacing it will do an excellent job. For this reason James believes cotter pins and similar attachments that engineers take for granted are ineffective.

Troubles in testing the original Weasel in the Arctic further exemplify what the designer is up against. The test machine bogged down completely because of ice formation under the sprocket drums stemming from friction-generated heat. It kept building up to a point where the track stretched so much that the engine didn't have enough power to turn over the sprockets.

Remedy in this case took the form of a thin rubber coating on the drum surface that permitted sufficient flexing to prevent this ice build-up.

As for materials, James advises that comparing relative properties at low temperatures of say cast irons is not the sole selection criterion. Whether the material is basically the right one to begin with should be the prime consideration. Does iron, steel, copper, aluminum, or magnesium have the basic qualities we want in the part for cold-weather work or will plastics or wood be better? This the designer should ask himself as the first step in material selection.

Proper materials and simple design pay off in vehicle servicing under frigid conditions. Steel sleds, for example, perform well until they break down - usually miles from a base. Sleds of wood and rawhide simplify the servicing problem since a handkerchief can be used to tie together the broken pieces.

The SAE group, headed by C. H. Lorig, Battelle Memorial Institute, has gathered other information on the subject. A questionnaire recently circulated brought 59 replies from casting users relating their experiences and practices with ferrous materials for sub-zero uses.

Seek Industry Unity On Precision Castings

SOUND industry practice for specifying surface quality and dimensional tolerances of precision castings is being pursued by the Precision Castings Division of the SAE Iron & Steel Committee.

In preliminary discussions the conferees agreed there should be established a standard system of grading surface finish and a way of measuring this grade or class of finish.

Currently, finishes are being evaluated in a number of ways. Visual comparison with standard photomicrographs, profilometer, and brush-type analyzer are just a few of the methods. A few method mentioned at the last meeting of the group involves a plastic replica.

First step with this latest technique is to apply suitable solvent to the metal surface. Then a plastic film is pressed on which is permitted to flow and to conform to minute surface irregularities. After about 1 min of drying the film is stripped and evaluated by the character of transmitted light.

The evaluation instrument is a surface analyzer in which the film is oscillated in a plane interrupting a beam of light. The transmitted light hits a photo electric cell, causing a pulsating current to pass through a resistance. An a-c voltmeter measures the voltage drop across the resistance. These readings are calibrated in terms of profile value.

If light intensity striking the cell is constant, a constant direct current will flow in the circuit which will not register on the a-c voltmeter. But the transmitted light will vary in intensity because of difference in geometric characteristics of

the replica. This in turn varies the electron transmission which produces a pulsating voltage.

This method is still in the development stages. It took four months to get the first sample and only about two minutes to evaluate it.

The precision casting industry also sees a need for practical tolerances. Engineers often specify the impossible, being misled by the word "precision."

Chairman of the SAE Precision Castings group, R. J. Wilcox, Michigan Castings Co., asked the members to collect information on industry practice and recommendation as regards both surface quality and dimensional tolerances as a guide to further work.

Numbering Code Devised For Aero Utility Parts

A nonsignificant numbering system was adopted for the new SAE standard aeronautical parts program for three reasons: (1) it's better handled in IBM machines, (2) it makes for faster paper-work processing, and (3) it minimizes confusion.

The coding system will consist of six digits. Number range assigned to this program is AN 900001 to AN 999999.

At the last meeting of the SAE Engine and Utility Parts Committee, E-25, a representative of the IBM Co. advised that a coding system using numbers only is best for IBM tabulating, sorting, and key-punching equipment. Any significant-number coding system invariably involves use of letters.

He also said that use of letters in a numbering systems retards speed of these machines, reducing their capacity. Since most aircraft engine and propeller manufacturers use IBM equipment for paper-work, these two disadvantages of a combined number-and-letter system ruled out the significant code.

Third inherent shortcoming of a significant numbering system is the misinterpretation to which it's susceptible in written communications such as letters and wires. In the current AN coding system, for example, certain letters represent a number of things, depending on their position in the parts number.

Meaningsof such letters confuse some people. And typographical errors further complicate the problem.

The letter "A" is a case in point. It means at least four different things in the AN code. Before a dash in the AN 80 series it symbolizes a coarse thread. After a dash it calls for a bolt without cotter pin holes. In the AN 931 series, "A" before dash stands for grommets with a 1/8 in. groove. And the fourth meaning assigned to it is found in AN 960, where "A" specifies anodized aluminum. There are other multi-meaning symbols.

Technigrams. . .

CLUTCH FACINGS: Revived demand for dimensional standards, to cut down the 300 different clutch facing sizes and drilling patterns presently used, prompted the SAE Technical Board to survey industry on possibilities of undertaking such a program in SAE. Manufacturers of vehicles, clutches, clutch facings, and service outlets are being asked how they feel about it. An early SAE Recommended Practice on clutch facings, adopted in 1922 and revised in 1929, was dropped from the 1947 SAE Handbook because of obsolesence.

NONFERROUS METALS: Chairman of the SAE Nonferrous Metals Committee, W. E. Day, Jr.; Mack Mfg. Co., reports that his group will review and bring up-to-date all nonferrous metals specifications in the SAE Handbook for the 1949 edition. Seven subcommittees already have started the job.

PLASTICS: In conjunction with the Society of the Plastics Industry, SAE's Non-Metallic Materials Committee is classifying plastics suitable for automotive use. Physical, thermal, optical, electrical, chemical, and aging properties of each plastic will be given. Heading the project is N. J. Rakas, National Automotive Fiber Co.

FUEL TANKS: SAE Motorcoach and Motor Truck Committee's group on fuel tanks is following up its recently-completed recommended practice on side-mounted fuel tanks with a second covering other tank types. Chairman E. P. Gohn, Atlantic Refining Co., advises that a proposal covering tank construction, installation, and tests already is being studied.

ENGINES: The newly-organized SAE Engine Committee has announced as its first job a stem-to-stern review of all engine standards - gasoline and diesel - in the SAE Handbook. It's also considering new standards on items such as diesel fuel injection equipment, engine governor mountings, hydraulic pump mountings, and small single-cylinder power units. Harold White, Ford Motor Co., heads the Committee.

FOUNDRY PRACTICE: Last of a three-volume series of SAE Special Publications on foundry procedures is being readied for final Technical Board approval. The new treatise, Process Control of Brass and Bronze Foundry Procedure, will round out a trio of reports initiated by the SAE War Engineering Board at the Request of Army Ordnance. The first two, already completed and available, are SP-8, Process Control of Aluminum Foundry Procedure, and SP-20, Foundry Process Control Procedures (Ferrous Castings).

PARTS AND FITTINGS: Under aegis of the SAE Standard Parts and Fittings Committee, work is now under way to extend the number of Woodruff key sizes and to revise SAE standards on ball studs and ball and socket joints. New tapered and splined shaft-end standards are in final processing-approval stages.

BRAKES: Names of brake parts are being defined by the SAE Brake Committee to clarify the technical language. The project encompasses air, electric, hydraulic, mechanical, vacuum, auxiliary, and parking brakes. Illustrations will accompany name meanings.

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Student Branch News

ACTIVITY in SAE Student Branches continues its accelerating course, campus field editors report.

Six field trips, three talks on what industry expects of young engineers, and eight widely diversified topics were heard at student branches reporting up to the deadline since the April issue of the SAE Journal.

Detroit Institute of Technology members saw high-alloy automotive steels being made at Rotary Electric, and the next month inspected assembly lines at Kaiser-Fraser Willow Run plant.

Great care in burning away defects from ingots was emphasized, and the details of scale removal were explained.

A lunch, following the K-F plant inspection, was the occasion of an informal symposium by five engineers on various phases of passenger car production by modern methods.

More than 700 members and friends of Southern California Section were conducted through Northrop Aircraft, Inc., by the company's Institute.

Of the five speakers who explained various developments of that company, three were SAE Student Branch members. They were Robert N. Seeley, Delbert Corrigan, and Donald Marden, who described work on the Pioneer, XB-35, and YB-49, a jet-propelled flying wing.

Caltech student members studied tire manufacture at Firestone's South Gate, Calif., plant Feb. 13, from receiving Liberian and Malayan raw rubbers through mixing, testing mixes, fabrication, vulcanizing, wrapping and shipping tires and other products.

On. Feb. 27 the same group visited the Buick-Olds-Pontiac plant at South Gate where 250 cars are produced each day.

Timing, they were shown, is of the essence in this complex task where cars of the three makes, and with all the various standard trim combinations of paint and fabrics, flow off the single final assembly line without interruption.

Continental Oil Co. feted Oklahoma A & M Student Branch March 12 with a refinery inspection, dinner, and a symposium on fleet maintenance in the evening.

L. L. Pernot, Four Wheel Drive Auto Co., and A. C. Redden, Carter Carburetor Co., were speakers.

Following a business session at the same Branch on Jan. 29, Carl O. Monroe of the faculty, reported the diesel smoke symposium held at the SAE Annual Meeting in Detroit.

The SAE Branch joined other engineering students at Caltech Feb. 2 to hear Irvin Stalmaster, a Los Angeles consultant, discuss need for professional engineers to organize to better their position in industry.

He urged that such effort shun labor unions.

Northrop's SAE Student Branch heard a description of the design and development of a 190 cu in. racing airplane, the JR-1, Jan. 7.

Speaker was John T. Bennett, the Northrop Aircraft stress analyst.

What industry expects of young engineers was the subject March 4 and 11 before the College of the City of New York and on Feb. 14 at the University of Oklahoma Student Branches.

Bertram H. Saltzer, Wright Aeronautical Corp. personnel chief, not only outlined what employers are apt to look for in young men, but what graduates should look for in prospective engineering fields.

To be successful, engineers must sell their ideas. Technology alone does not suffice, M. C. Horine insisted before CCNY.

"A man who is unable to put over his ideas, no matter how good, is of little use to himself or to society," he said, explaining detailed steps in ac-

SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
SUMMER	June 6-11	French Lick Springs, French Lick, Ind.
WEST COAST	Aug. 18-20	St. Francis, San Francisco
TRACTOR and DIESEL ENGINE	Sept. 7-9	Schroeder, Milwaukee
AERONAUTIC and AIRCRAFT Engineering Display	Oct. 6-9	Biltmore, Los Angeles
PRODUCTION MEETING and CLINIC	Oct. 21-22	Statler, Cleveland
FUELS and LUBRICANTS	Nov. 4-5	Mayo, Tulsa
	• 1949	
ANNUAL MEETING and Engineering Display	Jan. 10-14	Book-Cadillac, Detroit
PASSENGER CAR	March 9-11	Book-Cadillac, Detroit
TRANSPORTATION	March 28-30	Statler, Cleveland

complishing this end.

The importance of the human element in engineering was the topic of an address by Baxter I. Scoggin before the University of Oklahoma Student Branch Feb. 18.

End product of engineering is used by people, and engineers must keep thinking what people want in products. As important, he said, is developing the knack of working with others because any important engineering achievement is the result of team work.

Following a business session of the Rensselaer Student Branch, H. E. Brunelle, General Electric Co. aircraft ignition chief, told of work on a high performance engine for light aircraft.

Efficient production and utilization of gasoline, a paper by W. M. Holaday was presented by Carl Habermann, Met Section student activity chairman on March 18.

A. C. Russell described a new carburetor he invented before the Oklahoma A & M Student Branch on March 18. The device was demonstrated before nearly 400, many of whom were Mid-Continent Section members.

Richard Sneed, Ethyl Corp., was the speaker before the A & M Branch Feb. 19 on supercharging.

University of British Columbia Student Branch heard Frank Elliott, Ethyl Corp., on engine maintenance on March 8.

Henry Dreyfuss, industrial designer, urged that automotive engineers work as a team with members of his profession to achieve the optimum in machines upon which civilization depends at Caltech's Student Branch March 1.

climbing up and down ladders aboard the LST 1069, tied up at Albany and used as a floating armory for training naval reservists.

Lt.-Com. R.G. Shanklin, the executive officer and an SAE member, described features of the diesel propulsion units and told of experiences in maintenance and operation of these engines.

Fayette Leister, Fafnir Bearing Co.'s vice-president in charge of engineering, who spoke at CLEVE-

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News of Sections

CONTINUED FROM PAGE 84

Constant research now going on, he is sure, will add further improvements to match those of super-cushion tires, air foam cushions, better weight distribution, and other innovations that have added to riding comfort in recent years.

Transoceanic aircraft operation was shown to be the most complex and demanding form when John G. Borger, chief powerplant engineer for Pan American World Airways, described its problems and achievements before SOUTHERN NEW ENGLAND Section, March 3. Of particular importance are fuel economy, increased payload, simplification of equipment, trouble-shooting during flight, and reduction of a too-high rate of powerplant failure.

MOHAWK-HUDSON Group members spent the evening of March 25

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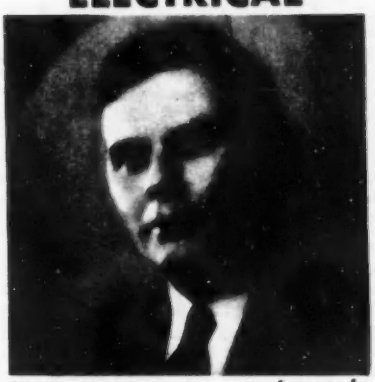

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Silicone News

DC SILICONES

Ford Uses Silicone Grease in Bearings at 700° F.

7200 Trolley Bearings lubricated with DC 41 Silicone Grease withstand 700° F. in Ford Core Oven Conveyor Systems.

PHOTO COURTESY FORD MOTOR COMPANY

The cost of designing around the thermal limitations of organic greases is often prohibitive. In such cases, frequent relubrication, high maintenance costs, and production stoppages were inevitable until Dow Corning introduced a line of semi-inorganic silicone greases serviceable at temperatures far above the limits of organic greases.

The economy of this new solution to high temperature lubrication problems is demonstrated in the core oven conveyor systems operated by the Ford Motor Company. These core ovens operate 16 hours a day, 5 days a week, at a peak heat of 700° F. The 7200 trolley bearings are exposed to such temperatures for 2½ hours out of every 4 hours. Even with automatic oiling, the bearings froze, wheels were flattened, and production was interrupted.

After careful testing, Ford's Chemical Engineering Department recommended DC 41 Silicone Grease. Lubricated with this heat-stable silicone grease, the conveyor systems require considerably less power to operate. They start easily and run continuously. Replacement and maintenance costs are greatly reduced and the bearings exposed to 700° F. are relubricated only once a week.

If you have a high temperature or permanent lubrication problem, write for Dow Corning Silicone Grease data sheet No. D 7-2 or call our nearest branch office.

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LAND Section's March 8 meeting, described progress that has made ball and roller bearings a $275,000,000 business, and told of the SAE's role in establishing international standards on dimensioning and tolerances.

NORTHERN CALIFORNIA Section held its semi-annual student meeting on Jan. 28, and heard two Stanford engineering students, Harold E. Secrest and John J. Garland, Jr., present papers that tied in the student paper contest.

The former held that peace can be attained through proper use of the tools of science, religion, and psychology.

Simplification of lubrication is keeping pace with the simplified operation of modern automobiles, trucks and buses, Bruce B. Farrington reported at NORTHERN CALIFORNIA Section's Dec. 9 meeting.

Farrington, who is with California Research Corp., said that the introduction of hydraulic clutches and automatic transmissions has required development of transmission fluids of increased resistance to oxidation and gum formation.

CONTINUED FROM PAGE 75

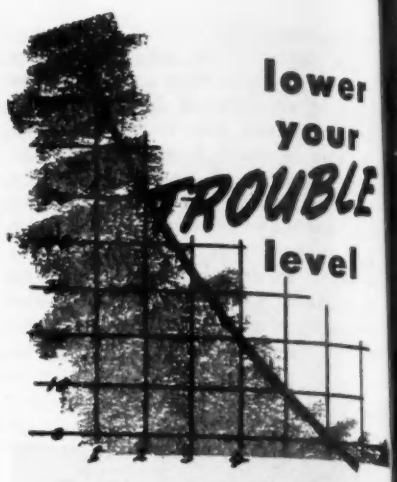
Wise Choice of Springs Cuts Rotor Vibration

Digest of paper

By BARTRAM KELLEY
Bell Aircraft Corp.

DEFLECTIONS and stresses in helicopter masts, engine suspensions, and blade shanks may be minimized through proper choice of the physical constants of the rotor system, application of the theory of vibration isolation shows.

According to the theory, an intermediate member in a mechanical system of masses and springs can be made to carry little or no stress in spite of severe vibrations. Thus, motions can be isolated from masses and stresses can be isolated from springs. Unfortunately, the motion of the mass farthest from the exciting force and the deflection of the



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". . . Stuart's SOLVOL was put in on a trial basis for milling high carbon alloy steel. High-speed alloy cutters were used and it was found that SOLVOL increased the cutter life 3 to 4 times over what they had been getting."

". . . on switching to SUPERKOOL, operator reported less mist from the precision grinding machine . . . production increased to 200 pieces . . . finish improved 2 to 4 micro inches . . . foreman and lubrication engineer well pleased."

"Stuart's SOLVOL was put in on a trial basis for use in milling machines on high carbon alloy steel. High speed alloy cutters were used and it was found that SOLVOL increased the cutter life three to four times over what they had been getting. This customer is well pleased with SOLVOL and will continue to use it in the future on these machines."

The above case studies are typical of results being secured throughout industry with Stuart oils correctly applied to the job. D. A. Stuart Oil representatives are not miracle workers, but they have back of them a tremendous fund of experience and technical assistance. If you are having trouble due to cutting oils you can count on them to minimize the troubles. Write for D. A. Stuart booklet, "Cutting Fluids for Better Machining."

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connecting spring can never be made to vanish. The last element in the chain will always receive a small amount of vibration, but the vibration can be made very slight if spring flexibilities are chosen wisely.

Equations which show how great the deflections will be as a function of the physical properties of the system have been developed and are given in NACA Advanced Restricted Report No 3G29, July, 1943. "Theory of Self-Excited Mechanical Oscillations of Hinged Rotor Blades," by Robert P. Coleman. The equations cover the case of unbalance, where one blade is heavier than the other, and the case of unequal drag, where with a two-bladed rotor the unsymetrical airflow through the disc creates a large pulsating force on each blade.

(Paper "Helicopter Vibration Isolation," was presented at SAE Annual Meeting, Detroit, Jan. 16, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

■

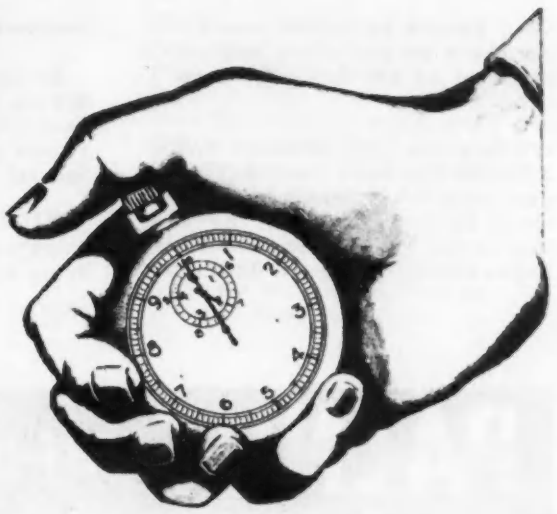
Functioning under the sponsorship of the SAE Hawaii Section are Divisions of the Section on the Islands of Maui and Hawaii. Each is active and holds regular technical meetings throughout the year. Local activities are headed by Section Vice-Chairman Hollis Hardy representing Maui, and William O. Harper, representing Hawaii. In March, Section Chairman David R. Mikkelson and three other members of the Governing Board made a flying trip to the two islands and met with the local groups. They report keen local interest, particularly in the operation and maintenance of problems faced by the pineapple and sugar industries in transferring to automotive equipment.

About SAE Members

CONTINUED FROM PAGE 79

JAMES GORDON CARROLL is research engineer for the California Research Corp., San Francisco, Calif.

2 Minutes to apply by immersion



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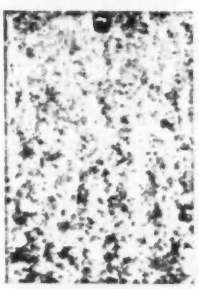

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JR., is now executive assistant to the vice-president and chief engineer of the Mack Mfg. Corp.

Since Jan. 15, RANDALL WAYNE JOHNSON has been in the Transportation Sales Department, Trane Co., La Crosse, Wis. He was formerly in the Engineering Department, General American Aerocoach Co., East Chicago, Ind.

No longer general manager of Hooven Business Machines Corp., Hamilton, Ohio, ALFRED A. HEALY is now plant manager of Hardware Specialties Inc., Plano, Ill.

RICHARD GLOVER MARKHAM is supervisory trainee for the Lily-Tulip Cup Corp., New York City.

Prior to becoming president of Le Roi Co., Milwaukee, Wis., E. A. LONGENECKER, was president of Lauson Co., Division of Hart-Carter, New Holstein, Wis.

No longer assistant to controller of Curtiss-Wright Corp., Caldwell, N.J., JESSE E. WHITE,

ALONZO R. KETCHAM is sales engineer for DeBoliac Truck Service & Equipment Co., Miami, Fla. Prior to this he was production control manager with Gar Wood Industries, Inc., Wayne, Mich.

Now staff research engineer for Research and Development Division, School of Mines, Albuquerque, N.M., BRUCE EDWARD HORERSON had been employed as engineer, in the Research Division of Fairbanks-Morse & Co., Beloit, Wis.

L. H. NAGLER recently became technical advisor at Nash, Detroit, in the Advertising and Sales Promotion Department. He had been technical editor of MoToR Magazine in New York City.

Until recently an aeronautical research scientist with the National Advisory Committee for Aeronautics in Cleveland, WILLIAM D. EDWARDS is now a research laboratory analyst with the Boeing Airplane Co. in Seattle, Wash.

Formerly assistant group engineer with Glenn L. Martin Co., ARTHUR N. CURL, is now designer in the powerplant instruction group for Bell Aircraft Corp. of Buffalo, N. Y.

Now with Marina Development Corp., West Palm Beach Marina, Florida, as executive director, HARRY E. ZUST had been superintendent of maintenance, Southern Division, for Associated Transport Inc.

Before joining Kurtis-Kraft Inc., Los Angeles, Calif., as engineer, JOHN R. BOND was project engineer for L. G. S. Spring Clutch Corp. in Indianapolis, Ind.

J. A. RINEHART is taking the Advanced Management Program at Harvard University. This course began on Feb. 22 and will run to May 22.

Now automotive specialist with National Carbon Co., Inc., Atlanta, Ga., ROBERT J. FOLEY was formerly affiliated with Wright Aeronautical Corp., Wood-Ridge, N.J.

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Inverted PALNUTS

For moulding strips, medallions, tail and parking lights, radiator grilles, etc. Replaces regular nut and lock-washer.

Washer PALNUTS

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Pleasing dome shape covers bolt ends, improves appearance, protects car owners from injury. Used on glove compartments, rear decks and license brackets. Self-locking, replaces regular cap nut and lockwasher.

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TRADEMARK

E. F. NASON has been appointed general sales manager of the Elastic Stop Nut Corp. of America, Union, N.J. Nason formerly was aircraft sales and product manager.

OBITUARIES

R. H. McCARROLL

One of the key executive engineers of Ford Motor Co., Russell Hudson McCarroll, for a number of years in charge of chemical and metallurgical engineering and research, died, March 31, at the age of 58.

He was a member of the SAE Technical Board, and as sponsor for the SAE Iron & Steel Committee he was largely responsible for the outstanding achievements of that important technical group.

McCarroll was one of the most important members of the SAE War Engineering Board, and also found time to serve the Government in an advisory capacity during the war.

He was put in charge of all Ford, Lincoln, and Mercury engineering during the period of reorganization, when he brought to the company many of the leading engineers, chemists, and metallurgists of the country.

Before and since his work on that reorganization, McCarroll directed the 20-odd laboratories of the company, supervised materials specifications, directed the process, chemical, and metallurgical controls in manufacturing, directed the successful projects of casting procedures for crankshafts, camshafts, pistons, engine blocks, and other automotive parts. His patents were numerous.

Under the late Henry Ford's direction he conducted experiments to widen use of farm produce in industry.

He won his bachelor's degree in chemical engineering at the University of Michigan in 1914. He was a member of other technical societies.

McCarroll's contribution to technical literature has been voluminous, including papers presented before the SAE. His last, Production Process Control – What it Can Do for Quality, Costs, and Volume, was presented March 3 at the SAE National Passenger Car & Production Meeting, Detroit.

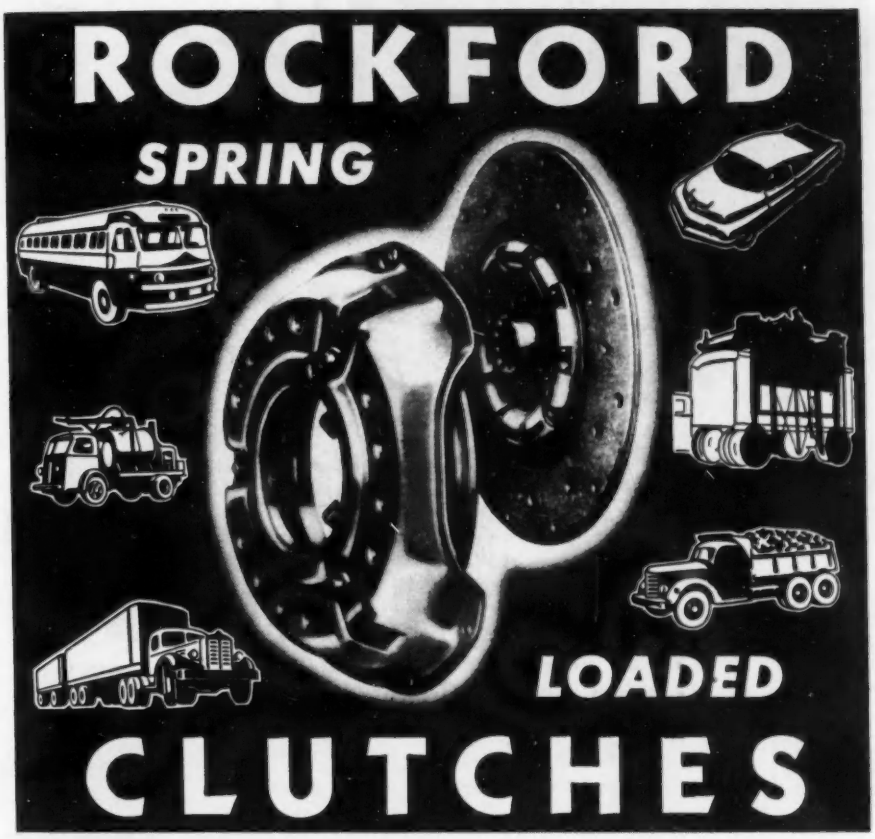
HARLOW HYDE

One of the most active SAE members in the Middle-west, Harlow Hyde, died April 4 at the age of 74 in his home in Indianapolis.

For more than 15 years he was secretary of the Indiana Section, and was largely responsible for its growth through the years since he became a member in 1928.

He was born in Vermont, educated at the University of Vermont, and was successively in advertising work for Bosch Magnete, Stevens-Duryea, Empire Automobile Co., Nordyke-Marmon, and Stutz, and was connected with the Indianapolis Speedway in various capacities.

He wrote numerous articles for trade publications in the automotive field, and served as advertising consultant. For a number of years he was the Section's SAE Journal Field Editor.



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New Members Qualified

These applicants qualified for admission to the Society between March 10, 1948 and April 6, 1948.

Grades of membership are: (M) Member; (A) Associate; (J) Junior; (Aff.) Affiliate; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: H. Shelton Almony (A), Robert G. Blaylock (SM), Dalton Scott Bruce (A), Dale D. Collins (M), Horace E. Crawford (M), Robert W. Reynolds (SM).

Canadian Section: Herman L. Cabana (A), John Graham MacDonald (M), F. J. Mitchell (A), W. L. Moore (A), Colin Edwin Morrison (M), Karl Barton Raham (J).

Central Illinois Section: John E. Jass (M), Willard H. Jensen (J), Roy F. Kern (M), Fred Richard Lofthouse (J).

Chicago Section: Angelo Jack Angaran (J), O. K. Butzbach (M), E. Francik (A), Russell T. Griffith (M), Michael J. Jeswick (J), Roy Kamo (J), Seth T. McCormick (M), Frank J. Pryatel (M), William Repenning (J), Alex Sarantos Tremulis (A).

Cincinnati Section: Richard M. Stanley (A), Gene Steinkamp (A).

Cleveland Section: Angelo R. De Vito (M), Howard J. Dieckow (A), George T. Downey (M), Carl Dudugjian (J), James B. Kelley (M), Edward Sich (J).

Dayton Section: James W. Ashby (A), Carl M. Garner (SM).

Detroit Section: Robin A. Bell (A), Renato R. O. De Pina (J), Thomas Edward Dolan (J), Robert B. Eckel (J), James Fred Elwell (J), John J. Ferszt (A), Howard E. Geer (J), Fred W. Gerow (J), Walter B. Herndon (M), Eugene E. Hildebrandt (J), Arthur D. Jackson (M), Taga E. Juul (J), Edward Koczat (J), Harry R. Mitchell (M), J. E. Rheim (A), Howard E. Scharfenberg (J), Wm. M. Schmidt (J), Charles R. Shanks (A) Kenneth L. Swarthout, Sr. (M), Steve Toth (J), Frank C. Weiler (M), Francis E. Woodburn (A).

Hawaii Section: Robert S. Craig (A), Howard F. Ladd (A).

Indiana Section: Kenneth M. Leech (M), Carroll K. McCullough (M), Darrel E. Peugh (J).

CORRECTION

In the article "Announce Facts About New Softer Tires," pp. 22-28 of the SAE Journal, March, 1948, the two Fig. 2's, one for each section of the article, were transposed. The Fig. 2 shown on p.24, in the section "What They Do. . ." by G. H. Parker and Edgar Shay, belongs with the caption on p.27, with the section "What They Are. . ." by W. E. Shively. The chart of cleat-test results on p.28, is the one referred to in the caption of Fig. 2 on p.24.

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Kansas City Section: Gayle Woody Pipes (J).

Metropolitan Section: William Geo. Atkinson, Jr. (J), James D. Bradley (M), Fred Paul Burns (J), John Hays Caperton, III (J), Richard Henton Daily (A), Ralph M. Hill (M), Eugene Marshack (M), Elfried F. H. Pennekamp (J), George A. Viehmann (M), Eugene Frederick Zimmerman (A).

Mid-Continent Section: Henry Phillip Anderson (A), Martin H. Clark (A), Donald B. Pruess (M), Robert M. Schirmer (J), Lynn G. Thompson (A).

Milwaukee Section: Otto A. Bossart (M), Wm. H. Lewis (A), Paul F. Quick (J), Harry W. Roorda (M), Dean Edward Rudig (M).

New England Section: Alfred H. Johnson (J), Abe Thall (A).

Northern California Section: Ralph J. Doyle (A), Dan M. Finch (M), Robert Leighton Harris (J), Berent Nathaniel Knutsen (J), Wilson D. Patterson (A).

Oregon Section: Stanley B. Loye (A).

Philadelphia Section: Wm. F. Fisher (J), Ray E. Greeger (M), John T. Richards (J), Theodore C. Scarlett (J), Frank H. Whiting (J), Louis H. Winkler (M).

Pittsburgh Section: W. L. George (M).

St. Louis Section: Harry W. Faust (M), George L. Hayes (M), William S. Hoock (M).

Southern California Section: Robert Cyrus Lyon (M), Robert Stewart McCord (A), Gilbert Russell Moore (A), Fred W. Trebes (J).

Southern New England Section: James L. McCoy (A), Harold Edward Robbins, Jr. (M).

Syracuse Section: Carmen D. Cianflone (A).

Texas Section: Z. N. Baker (A), Lamont S. Emanuel (A).

Twin City Section: Martin T. Schiska (A).

Virginia Group: Thomas Z. Gregory (A), Richard Stanley Stewart (A).

Washington Section: John R. Anthony, Jr. (A), Ahmed Moheyeddin Salhab (J), Milo Wesley Snider (M).

Western Michigan Section: Adolph G. Anderson (M), Robert R. Campbell (M).

Outside of Section Territory: Berthoud C. Boulton (M), Eugene Howard Case (A), G. E. William Eck (A), Arthur Wilfred Gilmour (A), J. M. Meldrum (A), L. W. Ross (A), John F. Shaw (M), Robert W. Stieg (J), Peter V. Toffoli, Jr. (J).

Foreign: Hilton Harold Batt (J), Australia; Ramkrishna Ganesh Damle (A), India; Ernst Otto Edelmann (FM), Sweden; Charles Fletcher (FM), Australia; Ir. J. Hardonk (FM), Holland; Joseph Jones (FM), England; Raymond Louis Rene Lucas (FM), France; Alan H. Strutford (FM), England.

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Applications Received

The applications for membership received between March 10, 1948, and April 6, 1948, are listed below.

Baltimore Section: Kenneth P. Bowen, John Clifford Martinka, F. J. Smith.

Canadian Section: Robert M. Foote, Stuart P. Jones, A. Roy Jupp, Douglas W. Marshall, Harvey James Patterson, John A. Smith.

Central Illinois Section: Wayne Lasky.

Chicago Section: Oscar T. Ericson, Robert W. Helbig, E. Clem Jensen, Kenneth Holston Myers, Harvey J. Rowe, David C. Stukey.

Cincinnati Section: Norman G. Stedron.

Cleveland Section: Elmer Anderson, Thomas P. Christen, Jr., Willard H. DeBruin, Ernest N. Dregalla, Matthew C. Kuepfer, Edward T. Kump, Arch R. Miller, Elbert S. Rowland, Harold R. Russell, John A. Vitkovits.

Colorado Group: Theodore A. Olson.

Dayton Section: Darius S. Flinn, Robert William Huller, Coleman D. Kuhn, Robert H. Semenoff, Harry Hill Van Kirk, Jr.

Detroit Section: Jean W. Arnold, E. J. Cloutier, Jr., William Colquhoun, Donald G. Dean, Ned E. Dixon, Phil E. Haglund, Donald Herman Koch, Herman H. Mesick, Frank Nogar, Jr., George K. Ringe, Albert C. Russell, Randall A. Sanger, William H. Vaughn, J. E. Vollmer, Frederick A. Weihe, Jr.

Hawaii Section: Charles R. Baptiste, Philip Beverly Brown, Rolland Francis Fetters, George M. Gilmore, Henry Hughes, Harold J. Hutchins, Jack Christian Latte, Tetsuo Mihara.

Indiana Section: Carl F. Lauenstein, Paul L. Schneider.

Metropolitan Section: Stanley E. Abramson, John Henry Crowder, Jr., Charles C. Faroni, Paul E. Friend, John W. Griswold, John Sleater Jaquith, Walter J. Knies, Richard Charles Knoeckel, Jr., George F. Marshall, Joseph Francis McPartland, Jr., R. J. Masiello, John Mikulak, Charles Mitchell Parker, Seymour J. Raymond.

Mid-Continent Section: Donald William Frison, Dudley Edwin Griffin.

Milwaukee Section: Raymond S. Saddoris, Ben G. Thiel.

New England Section: J. L. Wilson.

Northern California Section: Walter E. Nelson.

Philadelphia Section: John R. Bates, David H. Kaplan, Victor M. Mantz.

Pittsburgh Section: Carl W. Weesner.

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